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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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Large Resistance Furnaces.—In an interesting article on "Industrial Electrical Heating," by Mr. J. G. Pearce, B.Sc., in the July issue of "The Metropolitan-Vickers Gazette," the author refers to the large resistance furnaces employed in America. During the war very considerable strides were made in the applications of these wire-wound furnaces, and the largest types were actually used for heat-treating gun forgings. These large furnaces use nichrome ribbon in sections up to 2 in. wide by $\frac{1}{8}$ in. thick in loops supported by refractory insulating members projecting from the wall of the furnace. The furnace is 24 ft. high and 6 ft. dia. inside dimensions. The rating is 400 k.w. at 440 volts, 60 cycles. It was found that seven 4-in. tubes (22,300 lbs.) took 1,880 k.w.-hours and three 4-in. water jackets (21,700 lbs.) took 2,088 k.w.-hours. The weight treated per k.w.-hour amounted to 11.25 lbs., making 200 k.w.-hours per ton. A furnace is under construction of 10 ft. 6 in. dia., 105 ft. high, taking 2,850 k.w.-load and 320,000 lbs. of steel.

Some I.B.F. Historical Notes and its Future.

At the Birmingham Convention, mention was made of the presence of so many founders of the Institution. It is not generally known that the Institution was started as a result of correspondence in the columns of THE FOUNDRY TRADE JOURNAL. Mr. F. W. Finch, who is still Honorary Treasurer of the Institution, taking the advice of Mr. John G. Stewart, of Urmston, wrote to the Editor of THE JOURNAL for the names and addresses of his correspondents. The result was that Mr. Finch called a meeting at the Cobden Hotel, at Birmingham, on April 9, 1904. At this meeting Mr. Finch met Messrs. Robert Buchanan, who was elected the first President of the Institution, F. J. Cook, J. Ellis, C. Morehead, F. W. Shaw, and W. Vickers. Both Mr. Cook and Mr. Ellis afterwards passed through the presidential chair. Mr. Morehead, who is now living in London, has just transferred his membership from the Newcastle to the London Branch. The first Convention was held in Manchester the following August, and 43 members were present, the roll having grown in the meantime to 98, an infinitely better proportion than is obtained nowadays. A pleasing feature was that at that date everybody had paid his subscription. It is a pity that present-day balance-sheets have fallen from the original high standard. This factor of arrears is interfering with the excellent work which the Institution carries out. Programmes have to be curtailed, lecturers from a distance cannot be invited, and visits to works have to be kept to minimum on account of expense.

At this first meeting a model presidential address was given by Mr. Buchanan, and two scientific papers read by Dr. Longmuir and Mr. W. T. Maccal. We have noticed that some present-day stalwarts are always complaining that the papers now presented are too theoretical. Yet it was on theoretical papers that the Institute was nursed. Perhaps the great difference between the papers of two decades ago was that the readers seemed to possess a gift of making difficult problems appear simple. Nowadays, a lecturer occasionally gives one the impression that it is as much as he can do to understand his own conclusions. Foundrymen are to be congratulated that this type is rare amongst their lecturers. In general, the Institution has made enormous strides since its inception. Its general council meetings are now occasionally as large as the first general meeting. Summarised, it has been granted a Royal Charter; it has created a research organisation; it has already organised an international meeting, and at its next Council meeting will decide as to whether it is desirable to hold its next Conference in Paris, as an invitation has been received from the French foundrymen's association to do so. In this manner it will be following the lead given to it by the older associations. Once the principle is established, no doubt in future years Belgium, Scandinavia, Italy and perhaps the States will be visited. Such visits cannot be otherwise than beneficial to the industry as a whole, but obviously, should such an arrangement be accepted, there should also be a spring meeting, in order that those unable to go abroad can meet their President and fellow members. This would cover any objection that could be raised by those unable to participate. The status of the foundryman has been improved by its representative technical association, and all that remains to be done is to follow intelligently the path indicated by its energetic founders.

XUM

A French Opinion of Semi-Steel.

Mons. E. Ronceray, of Paris, in a written communication on Mr. J. Cameron's Paper on semi-steel, stated that he congratulated Mr. Cameron for his very interesting Paper, and thanked him for his too kind appreciation of his (Mr. Ronceray's) Paper on a similar subject given to the A.F.A. during the war.

He (the writer) was not very proud of his Paper, as he fell in a good many points in accepted errors of this time. His excuse is that it was then more urgent to help making shells than to argue.

Mr. Cameron considers the name of "semi-steel" as misleading, and he suggested that some translation of the French name, "fonte aciérée," is used. Perhaps "steely cast iron" would answer the purpose.

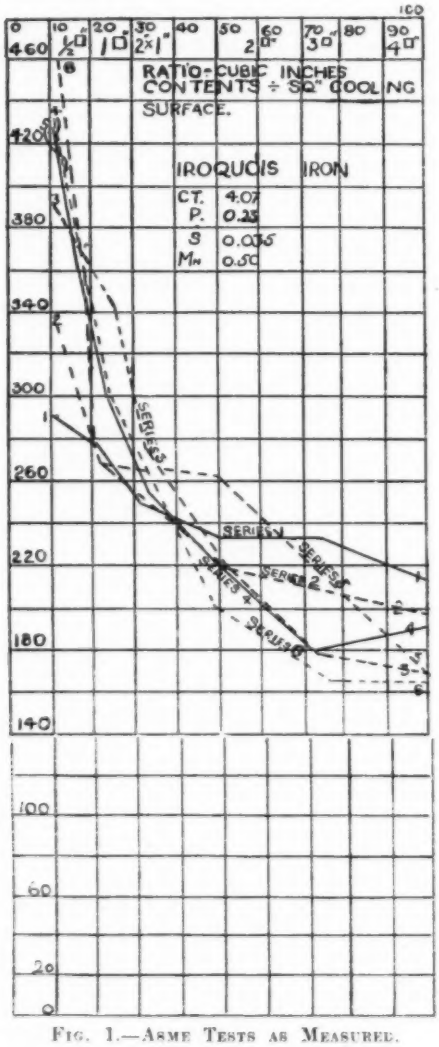

Fig. 1.—Asme Tests as Measured.

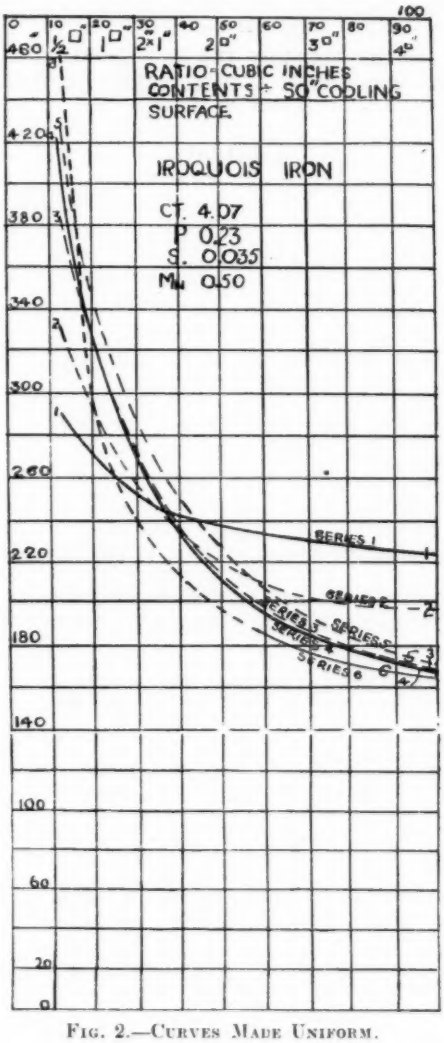

Fig. 2.—Curves Made Uniform.

So far as he could understand, the tests imposed by the British War Office were simply those of the French War Office translated in English measurements. The same criticism that he made in his Paper, "New Methods of Testing Cast Iron," applied. Those tests were valueless.

Colonel Prache mentions: "What has stopped possible improvements with semi-steel during the war are the tests imposed by the War Office. Those who have made semi-steel shells know that these tests had a very distant relation to the castings that were to be produced"; and also "War Office tests prevented foundrymen from making better shells." Portevin writes: "On the point of view of the quality of metal for projectiles, it was difficult to make a worse choice of testing methods."

The reasons were fully explained in his Paper, and he only wishes to warn those who have not had a long experience of these tests not to put the slightest confidence in them. Another proof of their unreliability is given by Mr. Cameron when he mentions that failures happened when the foreman had changed the moulder making the test bars. In fact, it is quite common that two bars cast in the same moulding box from the same gate give quite different results.

High Silicon in Cas Iron.

A point of Mr. Cameron's Paper which interested the writer considerably is his statement about high silicon test pieces. It refers to one of the writer's hobbies. Professor Turner did wonderful pioneer work when he investigated, more than 35 years ago, the influence of silicon on cast iron. He called attention to the importance of silicon on the condition of carbon, and gave a chart showing the influence of silicon on strength of cast iron. From this time the behaviour of silicon has been studied, and we are indebted to him for the considerable progress that has been made in the foundry in following the information given. About same time, on different lines, Gautier in France used silicon in cast iron to a great extent.

Professor Turner worked on what must be called artificial cast iron containing about 2 per cent. carbon, and used test pieces of only one size. Unfortunately, though Professor Turner mentions this point very clearly, many false ideas have been derived from the insufficient knowledge of these details.

After Professor Turner, Keep, the admirable American experimenter, made very important researches on the same question, dealing with commercial iron and using various sizes of test pieces, but he tested transversely, the most reliable of all tests for cast iron. He ventured to say that Keep was rather influenced by the results published by Professor Turner, for it seems that he did not

dare to draw the full lesson from his tests. Fig. 1 shows the original diagram of pages 120-121 of "Cast Iron," by W. J. Keep, amended only in showing the zero line that Keep left out, beginning his diagram at 160 lbs. This was done only to save space, but it was rather misleading. Alongside of it (Fig. 2) is shown the diagram corrected by him to make nice curves, and amended by the writer in the same way as the preceding one. It is quite clear that in the first diagram there is a knot of all curves between $\frac{7}{8}$ in. and 2 in. thickness, which the writer should translate by saying that between $\frac{7}{8}$ in. and 2 in. thickness a percentage of silicon between 1 in. and $3\frac{1}{2}$ in. makes no difference in the strength.

The writer has poured castings of about $1\frac{1}{2}$ in. thickness and even more with cast iron intended to be used for thin work, and containing more than 3 per cent. silicon, and the work was quite satisfactory. He has made this now for more than four years, with the result that a hard casting is almost unknown when other conditions are normal in the foundry.

TABLE I.—*Composition of the Iroquois Iron used in experiments detailed in Fig. 1.*

Series.	Per cent. nominal silicon.	Per cent. of silicon.						Si. av.
		½" sq.	1" sq	1" × 2"	2" sq.	3" sq.	4" sq.	
1	1.00	0.83	0.79	0.78	0.82	0.72	0.88	0.81
2	1.50	1.09	1.14	1.70	1.33	1.10	0.88	1.20
3	2.00	1.73	1.73	1.70	1.50	2.17	2.50	1.88
4	2.50	2.13	1.69	1.60	1.80	2.17	2.07	2.01
5	3.00	2.42	2.65	2.40	3.36	3.67	4.67	3.19
6	3.50	2.74	2.69	2.70	2.62	4.30	3.22	3.04

Other conclusions could be drawn of a careful examination of Keep's diagram, but this is not the place to examine them. He hoped to be able to return to the subject later, but he was pleased to read in Mr. Cameron's Paper full support of what he had found when Mr. Cameron mentions that a gate $1\frac{1}{4}$ in. dia, containing over 3 per cent. silicon, yielded a tensile strength over 18 tons. At the same time, he mentions that semi-steel seems sensitive to phosphorus and sulphur.

Phosphorus in Semi-Steel.

Referring to phosphorus, he believed that we do not seem to speak the same language when we speak of high phosphorus in semi-steel in France and in Great Britain. In Mr. Cameron's Paper, in semi-steel analysis the P is from 0.39 to 0.73. It is when there is 1 per cent. phosphorus that one considers phosphorus high. In France, semi-steel for shells has always been made with hematite, and the question is to know if the limit of from 0.06 to 0.07, or exceptionally 0.12 per cent., can be passed. He sincerely believed that it would be a great mistake to insist upon such low figures, for up to 0.30 the strength and probably the brittleness of cast iron is not altered.

Colonel Prache is afraid that it will probably be brittle. Careful experiments must be made to determine if such is the case, for the price of commercial semi-steel would considerably rise if the lowest figures are insisted upon.

The Limit of Sulphur Content.

The sulphur in analyses given in Mr. Cameron's Paper (0.150 and 0.143 per cent.) was not balanced by a proper amount of manganese; this is probably the reason why the iron would not run in small bars. The manganese ought to have been at least 0.50 to 0.70 instead of 0.26 and 0.34. Thousands of tons of semi-steel shells have been made in France with such percentage of sulphur (see analysis in the writer's Paper on "New Methods of Testing Cast Iron," where the sulphur varies from 0.12 to 0.22). These high percentages of sulphur are not to be recommended, but this resulted from the poor material available during the war, and it is comforting to know that they can be occasionally accepted.

Blow Holes.

Mr. Cameron shows test-pieces with blow-holes due to retarding the pouring. Many reasons can be the cause of such blow-holes, either what the writer calls "Custer effect" (air entrained with iron in pouring), or slag inclusions, or gas from either the mould or the metal. So it is of no use to discuss this point, so long as no more details are available about the condition of pouring, but this is not special to semi-steel; under similar conditions common cast iron would behave similarly. Damp sand, when used for ordinary cast iron, will produce the same result.

Cupola Practice.

He quite agreed with Mr. Cameron as to the size of cupolas to be used and their general arrangement with only one row of tuyeres and the rate of 1 to 4, but he differed with him about the interest of small charges. He was at one time of this opinion, and he had altered it, because, when the charges are small—that is, corresponding to 4 in. thickness of coke as recommended by Dr. Moldenke—the coke takes fire through the charges of iron too easily, and after a short time the flame appears to the top of the cupola, which then is working as a gas producer burning a large amount of coke for nothing and rendering the working of the cupola very hard. He had come to the belief that a thickness of 6 to 8 in. of coke and a corresponding thickness of metal are to be recommended. It means that in a 40-in. cupola he would not use charges less than 14 cwts. iron for 12 per cent. coke ratio.

Referring to the melting of steel, Mr. Cameron says that steel melts quicker than iron, pig and scrap. He was very surprised to read that it is a fact that the melting of succeeding charges takes place more or less simultaneously, especially when the charges are small.

Dr. Moldenke gives an evidence of such fact in his Paper of this year presented to the Rochester Convention of the A.F.A. But to admit what Mr. Cameron mentions needs more evidence than he gives. Very likely the pieces of steel melted first were of smaller section than the pig or scrap that he used. This would be a satisfactory explanation.

Gazette.

MESSRS. A. DEACON and J. H. QUARTON, stamped brassfounders, 97, Rea Street, Birmingham, trading under the style of A. Deacon & Company, have dissolved partnership.

THE partnership hertofore subsisting between Messrs. S. Pritchard and T. W. Etchells, engineers' merchants, 5, John Dalton Street, Manchester, under the style of Thomas W. Etchells & Company, has been dissolved.

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THE first meeting of the creditors of Mr. W. S. Harle, of South Shields, trading at Waverley Chambers, South Shields, as an iron and steel merchant, was held in Newcastle. The Official Receiver said debtor had lodged a statement of affairs, which showed liabilities amounting to £1,564, and assets to £230. Debtor was asked a number of questions about his trading, but on the suggestion of the Official Receiver, it was agreed that the matter should stand over until debtor was upon oath at his public examination. It is a summary case, and the Official Receiver is a trustee.

AT THE Sheffield Bankruptcy Court, on August 3, Mr. W J. Ritchie, Freedom Works, Sheffield, came up for his public examination. His statement of affairs shows a deficiency of £44,808. In answer to the Official Receiver, he stated that in 1908 he became a partner in the firm of William Hall and Company, of St. Mary's Road, Sheffield. Six months later he became sole proprietor and changed the trading name to W. J. Ritchie & Company. In 1911 he removed the business to Arundel Lane, Sheffield, spending £9,000 in plant and machinery. Before the outbreak of war his turnover was about £60,000 to £80,000, but afterwards this increased to £140,000 in connection with the Ritchie business and £150,000 in connection with the Crookes, Roberts & Company business, which he purchased in 1918 for £35,000. He entered into Government contracts for shells to the value of £60,000 to £70,000, and took a number of sub-contracts for the manufacture of aeroplane cylinders, the total of these being £80,000. The deliveries of these contracts were suspended by the Government, and at that time the debtor had £23,000 worth of finished cylinders on the premises. These had to be disposed of as scrap, and only realised £350. He attributed his failure to loss on Government contracts. The examination was adjourned to October 26.

XUM

The Foundry of the Renault Works.

The house of Renault, whose works are at Billancourt in France, claim themselves to be the largest manufacturers of motor-cars in Europe. They also claim to be unique, insomuch as that they can carry out, practically without any outside help, the whole of the operations necessary for the mass production of motor-cars. To do this they have had to build the various foundries of which the outstanding particulars are dealt with in this article.

Fig. 1.—General View of the Heavy Castings Foundry.—Messrs. Renault's Automobile Works, Billancourt, France.

Fig. 2.—Cupola Installation in the Heavy Castings Foundry.—Messrs. Renault's Automobile Works, Billancourt, France.

Steel Foundry.

This is the largest shop in the Works, with the exception of the Forge and Stamping Departments. It occupies three bays, each one being 7,250 metres square, and is served by five overhead cranes. The metal is melted in four cupolas which feed four converters, each one being capable of making three tons per hour. The moulding is practically entirely accomplished on the machine, there being no less than 40 moulding machines of all sizes in this Department alone. Additionally, there is an up-to-date mechanical and preparing plant served by transporters and elevators, which carry the sand to each machine, thus reducing labour to a minimum. In normal times no less than 500 tons of steel castings are made each month.

Iron Foundries.

In order to ensure an efficient organisation, Messrs. Renault have built three iron foundries, each one being devoted to its own speciality. Primarily, there is a grey iron foundry, specially designed for the casting of cylinders and, generally speaking, most of the castings which enter into the making up of a motor-car. The plant contained in this foundry comprises two three-ton cupolas, two overhead electric cranes, 24 moulding machines, and a mechanically-operated sand-preparing plant.

Additional to the above there is a grey iron foundry specially laid out as a foundry for machinery castings. It is furnished with three cupolas designed to produce 15 tons of liquid iron per hour. This shop is served by three overhead cranes. During the war there was cast in this foundry a casting weighing no less than 130 tons.

These two foundries are supplemented by a third one devoted to the manufacture of malleable iron. Three two-ton cupolas melt the necessary iron, whilst 30 moulding machines and a battery of eight annealing furnaces complete the installation.

The monthly production of these three foundries is 200 tons from the cylinder foundry, 200 tons from the machinery castings foundry, and 130 tons of malleable iron.

FIG. 3.—ONE OF THE FOUNDRY BAYS, MESSRS. RENAULT'S AUTOMOBILE WORKS, BILLANCOURT, FRANCE.

Brass and Aluminium Foundries.

These two foundries, which turn out all the non-ferrous castings used in the Works, are supplied with the most modern apparatus. The brass foundry is furnished with three tilting furnaces, eight moulding machines and mechanical sand-preparing plant. It turns out 80 tons of non-ferrous castings per month. The aluminium foundry contains the following plant: 11 tilting furnaces and 25 moulding machines, each one being served by small hydraulic jib cranes. Two overhead cranes span the shop, and, as is the case with all the other foundries, mechanical sand-preparing plant is provided.

In this foundry a section is devoted to chill castings, by which means mass-production castings are made, including gear and engine casings. The output of the aluminium foundry is normally about 80 tons per month.

MR. JOHN J. ASH has severed his connection with the British Thomson-Houston Company, Limited, and has entered into partnership with Mr. R. J. D'Arcy Hart, at 70, Victoria Street, London, S.W.1, where they are carrying on business as engineers under the name of Ash & Hart.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

The annual excursion of the Lancashire and Burnley Branches of the Institution of British Foundrymen this year took the form of a visit to the Works of the Staveley Coal and Iron Company, Limited. About 80 members attended, and a most enjoyable day was spent. The members were met at Chesterfield station by char-à-bancs and conveyed to the Staveley Works, when they were taken round the new Devonshire Works.

At 1 p.m. a most enjoyable lunch was provided. At lunch the company was joined by Mr. Chas. Markham, the head of the firm, and members of the staff.

After lunch the party were taken round the pipe and jobbing foundry, the visit coming to an end at 4 p.m.

Mr. J. Hogg proposed, and Mr. J. Haigh seconded, a hearty vote of thanks to the firm for their generosity and their kindness in making the visit a perfect success.

The thanks of the members of the branches are also due to Mr. G. P. Raundrop, for the trouble he took and the able arrangements he made for the success of the visit.

A Large Motor.—A new reversible electric motor developing 18,000 h.p., built by the Société des Atéliers de Constructions Electriques de Charleroi in Belgium, has lately been installed at the works of the Société des Forges de la Providence, at Charleroi, for driving their large blooming mill.

Brooklyn Suspension Bridge.—Reports from New York state that the Brooklyn suspension bridge across the East River is causing some anxiety among engineers, who point out that the bridge, although capable of standing strains far in excess of those for which it was originally designed, was never meant to bear the strain of heavy high-speed motor traffic, which for the time being has been stopped. Brooklyn Bridge, the centre span of which is about 1,600 ft., has several times been strengthened during recent years, but there is no means of reinforcing the four steel cables on which the main span depends. These cables are 15½ in. in dia., and each is capable of supporting a weight of about 12,000 tons. The actual weight of the bridge is 24,000 tons. The bridge comprises a footway, four tracks for subway trains and trams and two roadways, which reach a height of 135 ft. above the water-level.

An Apprenticeship Course in Foundry Practice.—V.

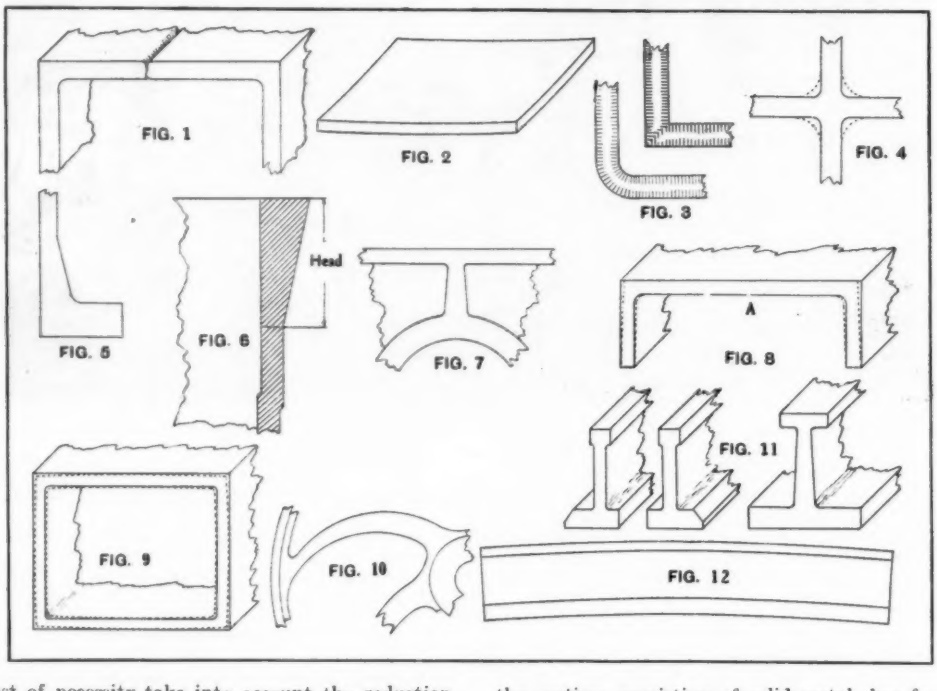
By Ben Shaw and James Edgar.

SHRINKAGE AND CONTRACTION—GENERAL CONSIDERATIONS.

When metals are heated, they expand, and when their temperatures are reduced to normal, they contract. This is a very important consideration in all structures involving the use of metals. In constructional steel work, such as bridges, special precautions must be taken to allow the steel work freedom to expand and contract, according to the varying temperature to which it is exposed. Rails, too, are set with a clearance between contiguous lengths, and the bolts through the fish-plates which secure them are eased as the atmospheric temperature increases, in order that the rails will be free to expand and thus reduce the possibility of them buckling. Even on buildings, where there is considerable steel work, it is necessary to make special allowances. It will probably interest many readers to learn that the Crystal Palace varies in length between winter and summer as much as 6 in. sometimes, because of the effect of the varying temperatures upon the steel work. The variations of temperature to which these are exposed are small in comparison to metal that is to be cast, and, as the change of volume is more or less proportional to its temperature from the molten to the normal condition of the solid casting, it follows that all those who are directly employed in the production of castings is subjected and the manner in which castings are influenced by the change in form comprise the greatest drawback to the production of sound castings. It is a constant source of worry and anxiety to the founder, particularly when a wide variety of castings are being produced, and his ingenuity and experience are often taxed to the utmost in devising means for reducing the effect of contraction on the increasingly complicated castings of to-day.

Crystallisation.

To understand the manner in which a casting is likely to be influenced by contraction, let us briefly consider how the metal contracts. It should be pointed out that, while the foundryman does not always regard shrinkage and contraction as separate action, they are indeed such. Shrinkage applies to the molten metal, and contraction applies after solidification has taken place. Between the two actions there is a distinct period. Directly the metal has been cast it begins to crystallise about the mould, that directly in contact with the mould surface solidifying first. The crystals arrange themselves at right angles to the surface, and the temperature is reduced from the outside to the inside, crystals gradually attaching themselves until the whole has become solid. Practically speaking, it may be asserted that, as soon as the mould is full of metal, a skeleton of



must of necessity take into account the reduction in volume from the molten state. In the case of cast-iron, the metal expands at the moment of solidification; according to Keep, there are three distinct expansions, after which the contraction continues gradually until the temperature is normal

Not only is it necessary to consider the change in volume or contraction to give it the recognised expression, but its influence upon the casting is equally as important. In constructional steel work the designer is responsible for the necessary allowances being made, and they are incorporated in the design, but in the production of castings it is mainly the moulder or founder who is made responsible, though the designer and the pattern-maker have an important part in assisting to reduce the difficulties of the founder caused by the shrinkage and contraction of metal. These difficulties are experienced to a more or less degree with every casting, and it is safe to assert that the shrinkage and contraction to which the metal the casting, consisting of solid metal, has formed against the surface of the mould, due to the rapid reduction in temperature. But the heat of the metal is not so rapidly given off away from the surface of the metal; thus it solidifies gradually from the outsides to the centre, and the time in which the whole casting will become solid will depend upon the fluidity of the metal when molten, the metal used, and the thickness of the casting.

Thin and Thick Sections.

The thin sections of a casting solidify more rapidly than thick sections. The comparatively cold mould absorbs the heat quickly, and the metal has not sufficient "body" to maintain any part of it in a molten condition; therefore, thin sections of metal solidify so nearly at one time that any slight difference in time of cooling between the outer surfaces and the centre is practically negligible. It is, in fact, necessary to increase the pouring temperature of metals which are to be used for castings having a light section, because

the temperature is reduced to such an extent in contact with the mould that, unless this precaution is taken, solidification takes places before the mould is completely filled, or, though the mould may be filled, parts may not properly connect. The metal is then said to be "*cold shut*." This simply means that, as the metal rises in the mould, its temperature is reduced to such an extent that, when ends meet, they are not hot enough to unite as shown in Fig. 1. But, while thin sections solidify almost immediately, it applies only to thickness and not to area. In casting a plate, for instance, the edge as well as the top and bottom of the mould absorb the heat from the metal, and this additional mould surface at the edges reduces the temperature of the plate out of proportion, which causes the casting to buckle or twist, in the manner shown in Fig. 2. Thick plates do not buckle so readily, because the cooling action is more prolonged, and they possess more "body" to resist bending.

The conditions differ considerably when the metal section is thick. A skeleton consisting of solidified metal is formed directly against the surface of the mould, but the increased body of metal causes it to maintain its heat longer, and the change from the fluid to the solid state of the full section is spread over a varying length of time. The difference in the time of solidification after the metal has been poured has an effect upon the amount the metal contracts. In thin sections that solidify throughout almost at once, contraction is regular, but with thick sections the contraction of the outside shell is restrained by the fluid metal inside, and instead of the metal contracting regularly, as in the case of the thin sections, the section becomes drawn and the texture of the metal more open towards the centre. Although the metal still contracts, it is not wholly external contraction, and the remaining fluid metal in the section not having sufficient power to draw the solid metal surrounding it, causes a certain amount of internal segration, which may be termed internal contraction. It is this fact which causes some hydraulic cylinders to "sweat," particularly when the metal thickness is greater than is necessary. Then the texture of the metal may be such that water may be forced through under test-pressures.

When castings are composed of both thin and thick sections, and there is considerable difference in the thickness, the metal must be poured hot enough to run the thin sections successfully, and, as these solidify quicker, they draw upon the metal in the thicker sections. In this way strains may be set up between sections of a casting which may be so severe as to cause a rupture, either before the casting has been removed from the mould or during the operation of cleaning it. Castings should therefore be so designed that the metal thicknesses are comparatively regular. Uniformity of thickness is rarely possible, however, as flanges must be increased in thickness, bosses cast-on and machining allowances made. The casting may be subjected to varying stresses necessitating various thicknesses of metal, or parts may be reduced in thickness merely to lighten the casting or to improve its appearance. In many cases, sections of a casting are made thicker than is necessary because other sections must be thick. This form of modification of the design to assist the founder is not always made in the drawing office, although it ought to be. When varying thicknesses must be made, they should be made as gradual as possible, in order that the cooling stress will be distributed over a wider area and not located in the angle of the abrupt change.

The Value of Fillets.

Fillets, as was briefly explained in the article on pattern-making materials, should be introduced wherever possible, not only to give greater strength by the increased amount of metal, but to prevent the weakness due to the crystal formation at re-entering angles. The enlarged sections in Fig. 3 show the comparison. A certain amount of discretion must be observed in the size of fillets used; thus, when two plates of metal intersect, as in Fig. 4, large fillets, illustrated by dotted lines, should not be used, otherwise the plates will draw upon the larger body of metal in the centre. While fillets are necessary when the sections adjoining are of similar thickness, they are almost essential also when an angle is formed between two sections of varying thickness, and when the contrast in thickness is great, fillets alone do not suffice to graduate the change of shape. It is better practice, and more helpful to the founder, to make the connections as gradual as possible, particularly in the case of steel castings. This is illustrated in Fig 5, which shows a heavy flange cast to a comparatively thin body; the wedge portion prevents the abrupt change, and, though the cooling strains cannot be entirely eliminated, the contraction between the sections is more gradual. This is frequently termed reinforcement. Another illustration showing the need of a gradual change between metal thicknesses is shown in Fig. 6. This is the form of head commonly cast on cylinder liners. Its thickness is greater than that of the liner, in order that it will be last to solidify, but, to reduce the resultant strain upon the liner, a gradual taper is given to the head. We are of the opinion that strains would be further reduced if the continuity of the head was broken by introducing cores in three or four places. This graduated thicknessing should be adopted also for webbing or ribs which are connected to sections that have considerable difference in their thicknesses in the manner shown in Fig. 7, just as it is considered necessary in the design of various forms of pulleys and wheels that have thin rims connected to comparatively heavy bosses.

Moulding Methods and Contraction.

In addition to the influence of varying thicknesses upon the contraction of the casting, different sections contracting against each other, together with the resistance offered by the mould, frequently alter the shape of the resultant casting, even when the sections are of similar thickness. Consider a casting having extended flanges at each end, but otherwise straight, as shown at Fig. 8. The length of the section A will tend to contract normally, but the resistance of the mould will prevent the flanges contracting to the same extent. The force exerted by A in contracting will draw those parts of the flanges in contact with it, and the mould will be crushed, but the influence of A is not sufficient to draw the full depth of the flanges the same amount. The resulting casting would, therefore, have a shape resembling that shown by the dotted lines. This is purposely exaggerated in the sketch to show clearly the contraction which may be expected to take place. Should the mould be too strong and offer greater resistance than the metal can overcome, then a fracture is almost inevitable, particularly with cast steel or aluminium, and, in a lesser degree, cast-iron and brass. If the illustration be extended so that the internal part of the mould is more fully enclosed, the metal surrounding it, as in Fig. 9, the sides of the boxed casting would contract in the same manner, but the sides would have very little influence in assisting the central parts to overcome the resistance of the mould. An exaggerated illustration of the influence of contraction in this instance is shown by the dotted lines in Fig. 9.

In each of the instances given above ribs or brackets may be introduced in the design to assist in maintaining the requisite shape, and, even though these would be helpful, they are not by any means a guarantee, and the moulder must take the necessary precautions to so weaken the internal mould formation that it will give to the pressure of the casting. But the mould must be strong enough to resist the pressure of the metal when fluid, so that in complicated work the resistance of the mould or cores and the counteracting influences of different sections prevent that amount of contraction which would be expected if the casting was straight.

Contraction Pulley Arms.

When the metal sections vary in thickness, similar influences operate, but they are accentuated by different rates at which the metal cools. Almost every reader will be familiar with the shaped arms in pulleys. These are sometimes referred to as contraction arms, because they "give" to the strain which is exerted upon them; thus their use prevents fracture or releases strains that would result in fracture ultimately. The rims of pulleys are thin for lightness, while the bosses are

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comparatively thick to give the requisite strength, the arms being tapered for the reason already given. After the metal has been poured for such a casting, the rim solidifies almost immediately the mould is filled, while the metal in the boss remains in a fluid state for some time afterwards, and, when contracting, it pulls upon all the arms which are connected with the rim. When the arms are straight, there is every likelihood of a fracture either of the rim or, more frequently, one or two arms are broken at their weakest section near to the rim. When the contraction arm is used, such as is shown in Fig. 10, the tension upon it merely tends to straighten it, and a fracture is averted. In large fly wheels the same difficulty is experienced, but it is diminished by constructing it segmentally or by separating the periphery in a number of places in order that, by localising the contraction, strains may be practically eliminated.

Camber.

Varying sectional thicknesses are equally as difficult when they are desired in castings which are long compared with their depth or breadth. There is then a tendency for them to warp, and an allowance has to be made when constructing the pattern, which is commonly called "camber." Castings such as lathe beds, girders, etc., are types subject to this change of form, cross-sectional views of which are shown at Fig. 11. The earlier contraction of the lighter section is contained by the fluid metal of the heavy section, and as the latter cools to a normal condition, it pulls upon the lighter section, which has become almost set, and in consequence the heavy section is more or less concave, as shown in Fig. 12, according to the contracting power of the heavy section overcoming the resistance of the lighter section. The method of ramming a thin layer of sand on top of the thick section after the metal has been poured and the core removed equalises cooling, and thus reduces the tendency to warp. If such a precaution is for some reason impossible, then the amount of camber necessary, while it may be approximately estimated by a man who has had a great deal of experience with the particular class of work in hand, can be determined accurately only by trial. Even when the pattern-maker has made a calculation based on a comparison of a casting with his pattern, it is necessary that the same moulder should be employed on subsequent jobs, or, at any rate, that similar moulding methods should be adopted, or there may be no improvement.

Pattern Allowances.

The pattern-maker is frequently responsible for modifications in a design with a view to facilitating the production of a casting in the foundry and to increase the prospects of a sound casting. He can only do this successfully, however, when he is working in close co-operation with those responsible for the work in the foundry. In addition to any slight alterations, such as the introduction of fillets, rounding corners, making abrupt changes of metal thicknesses more gradual, introducing webs or ribs or varying their positions, cutting through a wall of metal or increasing the size of hole through some unimportant part of the casting, he is also responsible for external contraction allowances. Moulds must be made larger, so that the metal cast in them will conform to requirements when cooled down, and just as metals and alloys vary, so do the constants for making the necessary allowances on the patterns. It would be comparatively simple if a definite constant could be used for each metal or alloy to be cast. Those young pattern-makers whose work has been executed without any departure from the recognised contraction allowance for cast-iron of 1-10 in. to the foot will probably be surprised, as they acquire more experience, with the number of variations from this rule. Different mixtures of the same metal vary in the amount of their contraction, according to the influence of their components. Grey-iron contracts less than white iron. Light castings contract more than heavy castings; thus for guttering pipes and any light work which has little or no obstruction to contracting, an allowance of $\frac{1}{8}$ in. to the foot is common practice. Then work of a complicated nature contracts less, depending upon the counteracting influences. An allowance of 1-16 in. to the foot is very frequently used for such work, and in some instances no allowance at all is made. These latter cases are exceptional, and refer to such cases as breeches pipes, when the centres between two branches, according to their design, are set out with the standard rule, or in semi-circular castings open at the ends and carrying an additional structure on the crown, which causes the diameter to open rather than contract. Even in the making of one casting the allowances often vary for different parts. A large reciprocating cylinder is a case in point. Usually 1-16 in. to the foot is allowed on all dimensions excepting the height, and with this practice varies considerably. Some make no allowance for contraction, but take the precaution to have additional machining allowance; while others allow for contraction, but are careful to back up the flanges in order that, if the casting should not contract the amount for which allowance has been made, the flanges will at least be thick enough after they are machined. It is not suggested that castings do not contract to the same extent vertically as horizontally, and the method of moulding is a probable cause, for it is well known that moulds have a tendency to "creep" when there are many joints. It is the practice of some pattern-makers, because of this, when constructing small and medium-sized work, to make distances from the main horizontal joint less than indicated in the drawing; thus, for grey-iron work the measurements would be made with a standard rule, and for brass work with an iron contraction rule.

Common Allowances.

The general allowance for cast steel is 1-5 in. to a foot, and for work up to, say, about 2 ft. it is quite satisfactory, but above that it is profitable to get in touch with the foundry doing the work, for their contraction allowance may be anything from 5-32 in. to $\frac{1}{4}$ in. to the foot, according to the work to be cast and the composition of the steel. The temperature at which the metal is poured influences the amount of contraction. There is another allowance to be considered with steel castings, which, though not concerned with contraction, should be made when the castings are to be annealed. The pattern is usually prepared to give at least 1-16 in. increase in the thickness of metal to allow for the removal of the scale which is formed on the surface after the casting has been annealed.

The usual contraction allowance for brass and gun-metal is 3-16 in. to the foot, but 5-32 in. to the foot is in common use for large work, slight variations being made according to the shape of the casting, and determined as the result of experience with similar types of castings. For aluminium, an allowance of $\frac{1}{8}$ in. to the foot is in frequent use, though many use the contraction rule for cast-steel or brass for comparatively small work, but in complicated work an allowance of 7-32 in. to the foot is sometimes used.

Strain-Reducing Devices.

Even though the designer and pattern-maker may have exercised their faculties to the utmost in order to assist the work in the foundry, it must be admitted that much remains for which the moulder must be responsible. It is his duty to so construct the mould that, while it supports the metal during the time of casting, its resistance is such that the contracting casting will overcome. In loam-work, straw rope or wood-wool rope is used for this purpose, and chopped straw and sawdust in the loam mixture; these burn after the metal has been cast and reduce the strength of the loam.

Loam bricks are used in preference to ordinary bricks when there is a possibility of the latter offering too great a resistance, whereas the loam brick will crush. Cores which are usually subject to the pressure of the metal from all sides merely consist of a shell of loam, the inside being filled with ashes. It is important to give ample clearance to grids or plates used to support cores. Artificially-bonded sands lose their bonded qualities to a considerable extent in the presence of the hot metal, making the sand fragile and more easily influenced by the contracting casting.

Ramming up wood blocks at the back of awkward projecting parts of a casting, which are withdrawn and their impressions filled with silver sand, have considerable value for weakening moulds

Although precautions of this nature may be taken, they may not suffice, and easing the casting by other means may be necessary. This consists in removing that part of the mould which is resisting the normal contraction of the casting, or key cores may be removed for the same purpose. The influence of unequal rates of cooling, with the consequent contraction troubles, necessitate special attention, particularly with cast-steel and aluminium. Thick parts of a casting may be exposed to the air, or they may be chilled with densers consisting of pieces of metal introduced into the mould and against which the thicker parts of the casting come. Metal being a better conductor of heat than sand, it reduced the temperature of the casting quicker. Nails are introduced for a somewhat similar reason, but they are surrounded with metal, and become part of the casting.

Feeders are invaluable for keeping thick parts of a casting supplied with live metal to make up the deficiency due to shrinkage.

Special Webs.

Thin webs are frequently cast between adjoining sections which vary in thickness, and at an angle to each other, to reduce the possibility of a rupture due to unequal cooling, or due to the resistance of the mould at a critical time. These thin webs solidify quickly and support the projecting parts. This is very common practice in steel foundries. When patterns are sent by outside firms, an apprentice pattern-maker fits a large number of these thin webs—usually about ¼ in. thick—between adjoining walls of metal. These are afterwards cut off the casting, and the men who have made the pattern do not in many cases know the precautions which have been taken by the moulder to ensure a sound casting.

The position and area of the runners and the temperature of the metal when poured have a certain influence upon the contraction of a casting Some moulds need to be filled quickly, while others are poured slowly by comparison. The subject of correct pouring temperature is a complex one, involving many considerations, but, as a general rule, it may be said that the temperature of the metal should be only sufficient to fill the mould completely and satisfactorily, unless the casting can be conveniently fed, when hotter metal may often be used with advantage to the casting, but having greater contracting influences.

The Value of Comparison.

The subject of contraction is extensive, although it has only been generalised in this article. Its purpose will have been fulfilled if it encourages observation in the foundry not only of the methods adopted to reduce strains under varying conditions, but the results when suitable precautions have not been taken, and many scrap-heaps bear witness to the fact that the difficulties resulting from shrinkage and contraction are not yet mastered. It is a very good practice for apprentices, if they have the opportunity of doing so, to compare castings with patterns, checking main centres and comparing contraction in different directions. A careful examination of a casting, using straight-edges on flat surfaces, will teach much. When several patterns of similar design are being made, the first casting produced will often suggest modifications which will lead to the subsequent production of castings of very accurate dimensions.

United States Steel Corporation Earnings.—The Corporation's net earnings during the first six months of 1922 and 1921, as compiled from the quarterly reports, were:—

	1922.	1921.
Net earnings	$46,626,930	$54,178,738
Dep., sinking fund, etc.	19,431,721	20,295,890
Net income	27,195,209	33,882,848
Int. U. S. S. bonds ...	10,089,622	10,320,211
Balance	17,105,587	23,562,637
Preferred dividends	12,609,838	12,609,838
Common dividends	12,707,562	12,707,562
Deficit	8,211,813	1,754,763

The directors have declared the regular quarterly dividends of 1¾ per cent. on the preferred and 1¼ per cent. on the common stock.

X-Ray Investigations on Metals.

DR. R. GLOCKNER, who has given a considerable amount of attention to X-ray investigations on metals, points out in an article in "Stahl und Eisen" that the interference photos obtained by different investigators on the same material often vary according to the technique adopted, and that a proper application of the method will only be possible when the physical principles of the process have been thoroughly studied. In this connection the writer has undertaken an investigation of steel for a large steelworks, and offers a number of suggestions as a result of his own work, and work by other investigators, on the examination of metals by X-rays.

The following, he states, are the most important factors upon which the interference image depends:—(1) The thickness of the test plates; (2) the cross section of the X-ray pencil; (3) the hardness and spectrum composition of the rays. There has been found to be a favourable thickness of sample for every material in which the interference spots occur very pronouncedly in a comparatively short time. This thickness depends upon the penetrability of the metal in question, being about 0.25 mm. for industrial steels. When preparing the test sample for X-ray examination, care must be taken to see that the structure is not altered by mechanical treatment. The writer has found the following method to be suitable: From the ingot or billet pieces about 5 mm. thick are sawn out and screwed to the wood chuck of a lathe. By means of a hand milling-cutter, a central circular section is turned out, leaving the form shown in Fig. 1.

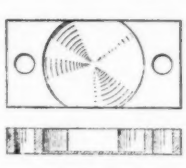


FIG. 1. FORM OF SAMPLES.

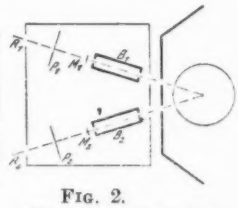


FIG. 2. TEST ARRANGEMENTS.

As regards the second point mentioned above, the smaller the cross-sectional area of the X-ray pencil the sharper the interference spots and rings on the photographs. On the other hand, the time of exposure should be protracted considerably, and in practice a medium must be struck between these contradictory factors. The workers in the writer's laboratory adopted a pencil of about 1½ mm. dia. Fig. 2 shows (B1 and B2) how the diaphragms are arranged, M1 and M2 show the method of setting up the samples under test, and P1 and P2 are the photographic plates. The entire arrangement is enclosed in a lead-lined box, the side of the box exposed to the rays being further protected by a lead screen. The use of two pencils of rays, R1 and R2, enables two samples to be investigated with practically the same amount of trouble as would be required for one.

The most important point is to select X-rays of favourable spectrum composition. Iron is a comparatively impenetrable material, and the tendency is to use rays of the maximum penetrability. This is correct when using the absorption process, in which the differences in density of thick pieces of iron are to be exhibited. The writer has determined the influence of the composition of the rays on the interference image by simultaneously photographing numerous compositions of spectrum by means of the spectograph and a special ray analyser. The best rays for practical purposes he found to be those whose maximum intensity is between 0.5 and 0.5 Angström (medium-hard rays).

The writer then offers the following suggestions for increasing the perfection of the process:—(1) By altering the design of the photographing apparatus (*i.e.*, arrangement of 4 or 8 pencils of rays simultaneously) the cost and time required may be reduced. (2) The most important problem is the construction of a special X-ray tube capable of giving rays of the composition required with a greater intensity of emission than is at present possible.

British Opinions on Making Castings without Feeding Heads.

Favourable Experiments Detailed

In our issue of June 1, we published M. Ronceray's Paper on the subject. The Paper was given before the London Branch of the Institution of British Foundrymen, and gave rise to an interesting discussion. The Branch-President (Mr. H. O. Slater) opened the discussion by stating that M. Ronceray had served the foundry world to great purpose, in that he had not only lectured to them in a most fluent manner, in a language not his own, but he had explained some fundamental principles in connection with moulding. He himself, like M. Ronceray, had carried out a number of experiments of the particular nature referred to in the lecture. Mr. Stone, a member, like many other foundrymen, could not accept the theory, but was convinced by practical experiments. The method was later extended to include gunmetal and other alloys. No doubt many of them were aware that malleable iron was something of a "hungry" metal, similar to manganese bronze and steel. One experiment was made, a spring bracket on a motor lorry, with a section of ½-in., with ribs leading to bosses of 3 in. dia. x 2¼ in. It was necessary, in order to get a sound casting, to have a feeding head on each boss, there being two bosses on the casting. The difficulty was not so much that of getting the metal sound underneath the risers, as in getting the risers off without knocking a piece out of the casting owing to design and the larger risers used. Necessity drove them to invention, and they cast these brackets with just a small riser, with about the same dimensions as mentioned by M. Ronceray, namely, 3-16th in. by ½ in. To make up for the feeding heads, they put 6, 9 and 12 ins. of extra height of runner on to these particular castings. The theory at that time was that the pressure would have some compensating effect for the risers. They had found that that was not altogether satisfactory in this particular case, owing to greatly unequal section, and there was difficulty with regard to the regular solidification of the metal. Having an advantage which in malleable iron they did not have to the same extent in cast iron work, owing to annealing, they put a chill on the bosses. The calculation they used was to have a chill half the size of the thickness of the boss to save the fusion of the chill and at the same time densening the bosses, and it was found that that regulated the solidification of the metal, and they got a perfect casting. They extended the method until they saved something like 20 to 25 per cent. of the melting charges on the shop as a whole. With regard to M. Ronceray's 6-in. shell, did he cast that shell with a core, and, if so, what did he allow for machining?

M. RONCERAY said it was cast with a core, and he had allowed 4 or 5 mm. on the radius.

THE BRANCH-PRESIDENT said that was ¾-in. a side for machining, and M. Ronceray had achieved something great. He had saved something like 20 to 30 per cent. on the machining charges of a shell. There was one thing which had come to his mind, and that was as to whether the secret of small gates and no risers lay in the use of hot metal. He was pleased to note, from the lecture, that the French moulder was like the English moulder, in that he followed out instructions as far as he could when being watched. It gave them satisfaction to know that they could not altogether denounce the English moulder any more than any other.

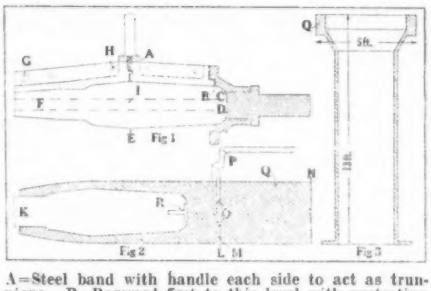
Casting Shells.

MR. A. R. BARTLETT, speaking in connection with the shell which M. Ronceray had mentioned, said that his firm had made many shells during the war, but he was sorry to have to admit that they had to cast them all with feeding heads. Their method of gating was certainly not that described by M. Ronceray, and he gave an example of their method of gating by means of a sketch. The shells were cast vertically and moulded vertically. They were made on a stripping plate machine, and possibly the way they were moulded had some effect upon the castings. They were moulded six in a box, which was round, and there was a core in each, as shown in Fig. 1. The core box is swung from the perpendicular for running to the horizontal for lifting from the box, when lifted out. It is then dipped into a blacking bin and hung on bars ready for stoving.

The reason for making heads such as are shown, was that they had a moulding machine converted to this particular use, and as it was the only machine which they thought would make them economically and quickly, they adopted that method. They had never had a reject, but they always had to break off the heads. He believed the general practice in England was to cast them, sometimes singly, in a box, but he understood many firms cast them two in a box, but with feeding heads on them. The runners were generally much smaller, when compared with what was generally accepted for a casting of that size. The castings weighed 49 lbs. each, and were for 4.5 gas shells. Six-in. shells were necessarily longer, and weighed little under 1 cwt., but they were run in the same manner, with a 9-in. head. He had had no experience of anything which was run in the manner M. Ronceray had spoken of.

M. RONCERAY asked whether the feeding heads were broken.

MR. BARTLETT illustrated the feeding head, and



A=Steel band with handle each side to act as trunnions. B=Rammed first to this level with protecting cap in position. C=This cap then placed on top and rammed. Three brads put it and wire withdrawn. D=Top plug then driven in to give finished shape and length. E=Split here for ease of machining. F=Print. G=Adjustable pin holes across corner, ¾ in. diameter. H=Bolt holes for fastening when machining, ¾ in. diameter. I=Core bar with vent wires placed in position first. K=Core print. L=Joint of mould. M=Core head broken off here with hammer. N=Top. O=Core. P=Runner. Q=Head. R=Chill.

how it was broken, by means of a sketch, reproduced in Fig. 2.

MR. BARTLETT then instanced the case of another casting, weight 8 tons 10 cwts., with a flange top and bottom, the casting being tapered. It was rather difficult to make, as will be appreciated from Fig. 3.

M. RONCERAY asked whether the head was sound.

MR. BARTLETT said that when cut off it was perfectly sound.

M. RONCERAY: And the top?

MR. BARTLETT: That was also perfectly sound.

Continuing, he said he had illustrated a small and a large casting, which more or less carried out what M. Ronceray had said. There were several small things such as machine-moulded castings, which we in England would never think of putting a riser on, and M. Ronceray's theory was carried out by his own experience of a good many small things. The fact which had interested him most was the coupling running through the centre, which M. Ronceray had mentioned. He had never seen such a thing done. He was not upholding all M. Ronceray's theories, but was just giving facts as he had found them in his own experience. He would like to know whether M. Ronceray found that he obtained a different result with a different chemical analysis of his iron. Did he find it essential to have a very high phosphoric iron for running castings with fairly thin section, and with such a small runner, or could he advocate any particular chemical analysis to be successful under his system?

Mr. Hall expressed his pleasure at having heard

a lecture by M. Ronceray. About June last year the lecturer had written an article in "La Fonderie Moderne," which had been translated by his (Mr. Hall's) employer and himself, and they carried out certain experiments, which were afterwards described in the FOUNDRY TRADE JOURNAL. One question arose out of those experiments, and that was with regard to the casting of shells. M. Ronceray, he believed, had cast shells, or had had them cast in France, the big side up. Was that correct?

M. RONCERAY said it was.

Mr. Hall said Mr. Bartlett was casting shells with the thick side up, with a feeding head on top. Was that correct?

MR. BARTLETT agreed.

MR. HALL said that during the war he had been taken to Woolwich Arsenal to see some of these shells cast. They weighed about 10 lbs., and at Woolwich Arsenal they were casting them with the heavy side up; there was about 1½-in. of metal on the thick side, and there was a runner all the way round about 1-16th-in. thick, with one down-stick. As soon as the shell was cool enough, they hit it, and it dropped out of the runner, but when put up for test the shells used to leak. His firm had taken on a contract for those shells. They at once commenced to cast them the thick side down, and had a 1-in. down-stick, which poured four shells. They would understand that there were four in one box, against Mr. Bartlett's six. They had the 1-in. down-stick to take all four, with a small runner in the bottom, and no riser. He was not going to say they had success every time, but under the hydraulic test they never lost more than 1 per cent., and there were never any wasters. They rammed very hard. The trouble in England seemed to be that we must not ram very hard, because if we did we should get scabs. Was it a question of the sand more than anything else? They knew the iron entered into it to some extent, but he wanted to find out what effect the sand had. He was still experimenting on these lines with different sizes of runner

Applicability to Steel.

MR. F. DARLEY (Messrs. Firth, Sheffield) said he had not had much experience with cast iron, but he was very much struck with M. Ronceray's method of slow running and cooling in order to get a solid casting, although personally he had very little faith in it. In his opinion they must have very hot metal to do that, and the hotter the metal the greater the contraction. In steel, with which he was concerned, it would be of no use at all, for the simple reason that they could not run a 1-cwt. casting with less than a 1-inch runner, and further, unless the steel were very fluid, *i.e.*, very hot, they would not get an intricate thin casting 1 in. thick and 5 ft. long with a runner of less than 1¼ in. He had also found that it was an utter impossibility to make a steel casting perfectly, where they had to feed a thick part through a thin wall. The contraction of steel was 7/32nd of an inch to a foot, whereas in the case of iron it was only 1/10th of an inch. He was rather surprised that brass and phosphor bronze was about 3/16ths. of an inch, nearly as much as steel. He had come to the meeting because it had been announced that the question of making castings without heads would be discussed, but he was afraid there was no chance of being able to make steel castings without heads, simply on account of the excessive contraction, and the difficulty of keeping the steel sufficiently fluid to run with a small runner.

Sand Experiments.

MR. E. H. BROWN said that he had been present last September at the conference of the Association Technique des Fonderie, at Liege, and he had had the pleasure of visiting both Messrs. John Cockerill's works, and also those of the Esperance Longdoz, and he would like to point out two or three fundamental factors on which their methods differed from those of the majority of foundries in England. First, with regard to Belgian sands, they were totally different from our own. They were produced from sands which were found, he believed, either on the outskirts of Belgium, or in Luxembourg, and sometimes, perhaps, in Germany, but the Belgians were producing a casting with a finer skin than we could produce, while that particular sand was far more porous. When he came back he had brought with him a box of sand from one of the foundries at Liege, passed it through a series of sieves, and compared it with an average sand in his firm's works at Newcastle. Whereas their own sand would barely pass through a 60 mesh sieve, he could pass practically the whole of the Belgian sand right through that, and about 45 per cent. of it through an 80 mesh sieve. That was considerably finer than most of them in England could use. Similar samples of sands, 3-in. square, were rammed under a Brinell testing machine, to get the same pressure on the two. He put through a constant flow of air, and for the purpose of the experiment he was using a carbon dioxide diffuser. The Belgian sand passed practically 25 per cent. more gas than the English, at the same pressure. With regard to the composition of the metal. The composition of the cylinders mentioned in the lecture was nothing like that of the cylinders he had seen made here and in Holland. He quoted an instance of some cylinders of very similar construction, which he had seen made during the five weeks he spent at a works in Amsterdam. They were making practically a similar type of casting with a head somewhere about 9 in. in height, tapering from about 3 in. at the top, to, roughly, 1½ in. at the bottom. The metal was nearly 0.5 per cent. lower in phosphorus than that which he understood was being used in Belguim, and the sulphur was considerably higher, certainly up to 0.15 per cent. almost every time. That necessitated a manganese content of well over 0.44 per cent., otherwise they would get sulphur blowholes. The manager of this particular foundry had told him that they could cast the same cylinder in what he said was identically the same composition of metal as used in Belgium, without heads, but when they tried their own metal, which, due to the sulphur content, was considerably thicker, it was impossible.

High Temperature Tests.

There was another point, with regard to temperatures of casting. When speaking of casting with hot metal, they must remember that hot metal did not mean the same to one foundryman as to another. He was astounded in the particular foundry he had mentioned, in Holland, to see the metal they were running through a cupola with a receiver. He had never previously, in this country, seen metal anything like so hot, and it had taken him nearly nine months' experimenting to get anything like it. He had ascertained, by the use of a pyrometer, that the temperature was somewhere in the region of 1,500 deg. C. With regard to the whole of the castings cast in Belgium, there was in Belgium practically nothing else than intensely high phosphorous iron. Iron was coming from Belgium and Luxembourg containing phosphorous up to 2.6 per cent. Was that the metal which M. Ronceray was putting into some of the castings he had mentioned? Because if so, the average Englishman would not look at it.

M. RONCERAY said it was impossible.

Semi-Steel Considered.

MR. BROWN, continuing, and dealing with the question of semi-steel, said he believed it was generally accepted now that semi-steel differed from cast iron only in the very slightly lower carbon content; the diminution was in the vicinity of 0.1 per cent., and there was also a somewhat lower manganese content. If they had to have a thicker runner for the semi-steel, did not that mean that with any thick metal the same would be necessitated? During the course of the last two years he had been casting some cylinder liners for a marine engine. The sulphur content was over 0.2 per cent., and it was deliberately kept at that high value. In the past there had been an enormous amount of trouble with the porosity in the top of those cylinders, and they had had some very big heads cast on them. With a 72-in. liner it was the usual practice to cast with an 18- to 21-in. head. He illustrated his remark by means of a sketch of a half-section of the liner.

Such a casting would show a depth of anything up to 72 in., and a thickness of metal of about 1¼ to 1½ in. except in one place, where it would be about 2½ in. After a good deal of experimenting

he had found that the shorter tapered head was considerably better than a long narrow one. The runners for these liners were cast on the top of the head; there were four runners, about 1½ ins. long by, roughly, ½-in. wide. As to the sulphur content, high-sulphur metal had advantages over low-sulphur metal in some ways. In dealing with a cylinder liner they were endeavouring to obtain a casting with a hard skin, resistant to wear, and also, when dealing with superheated steam it had to stand up to a fairly high temperature and still be resistant. Sulphur hardness maintained that resistance to wear considerably better under increased temperature than silicon. The average percentage of silicon in these liners was between 0.9 and 1.2, depending actually on the size of the liner. Manganese, of course, was higher still, about 1.54. He would like to know if M. Ronceray could suggest any method of running that particular type of casting with the same composition metal, and without the enormous head, because it ran into enormous cost both in melting the metal and in cutting off the head.

Gas Engine Liners.

MR. J. LONGDON said there was in this country a good deal of practice on the lines which M. Ronceray had laid down. The difficulty was that foundrymen, and perhaps English foundrymen especially, needed more courage. As M. Ronceray had pointed out, the principle was to keep the metal entering the mould at the thinnest possible part of the casting, in order to enable all the metal in the mould to set as nearly as possible simultaneously. He did not claim that he had tried the small section runner, but he had proved the validity of the principle of putting the metal into the mould at the thinnest place, so that the metal finally reached the heavy part when it was cooler, it being the last place reached by the metal, so that there was more chance of even cooling. Some years ago he had experience of casting gas engine liners, having sections pretty much as those outlined by Mr. Brown. The weight varied from about 14 cwt. downwards, the bigger ones having a section of about 2 ins., being about 4 ft. 6 ins. long, and cast on end. There was no big head cast on the end; there was a head of about 1½ ins., but it could not be claimed that that was a feeding head. Its function, he believed, was to receive gas holes or any scum that might have arisen through the operation of casting, and he was surprised to notice that no bad results accrued, such as one might have expected. In this case there were hundreds of liners cast perfectly sound, with perhaps three small runners on the top, each about 1 in. round. Mr. Brown had referred to the difference in the metal used here and on the Continent. He had said that the Belgian metal was higher in phosphorus and lower in carbon. He (Mr. Longden) was rather of the opinion that that told in favour of M. Ronceray, because if on the Continent they could get sound castings with a lower carbon content and a higher phosphorus content, that seemed to help to prove their case. He believed he was right in saying that the phosphide eutectic was the last to set in the casting, and that the contraction was greater than that of the pure iron. Consequently, there was a greater tendency for the production of the holes. Similarly, the absence of sufficient carbon would also tend to make for increased liquid shrinkage, because if the carbon were low there was less to precipitate, and when the carbon had been precipitated it took up a larger space than when it was in its combined form, thus helping to prevent shrinkage holes. He believed there was a great field for investigation in this particular matter, and there was no doubt that it needed courage, but he was quite satisfied that a great deal was to be expected of it, and a great deal of economy would result.

Pans made without Heads.

Some time ago he was responsible for the making of a number of pans weighing about 30 cwts. each. They were 4 ft. 6 ins. in diameter and 5 ft. deep, and he was staggered when he discovered that it was necessary to make them with a machining allowance on the top flange of ¼-in., and with no head. These were cast with three rectangular sectioned runners, each runner being about ½-in. by 1 in., and cast perfectly successfully, and perfectly clean on the top flange. That was something he did not expect, but it was being done, and there seemed to him to be great room for investigation.

More Successful Experiments.

MR. CREEK said he would like to give the author a word of encouragement. He had been up against something which had given him a lot of trouble; he had tried all methods, and could not get a sound casting in one particular case. After reading the article in THE FOUNDRY TRADE JOURNAL, however, it had given him an idea. He went down from a 1¾-in. runner to a ¼-in. down runner, and a very much smaller runner into the work itself. The first casting was absolutely sound, and from that day to the present he had had no further trouble with this particular casting. He had tried many other types with the same sort of metal, and it had been the greatest success in the foundry that he had ever had. He was convinced that there was a very great deal in this method of running if they could only experiment a little further. So far as the runners themselves were concerned, he had not quite followed the lines which M. Ronceray had indicated. Instead of having a down runner direct into the work, he had had a down runner and a cross runner, and a smaller one underneath that leading into the work. The result was, as he had said, a perfectly sound casting, and he had produced a great many of them. So far as iron was concerned, he had not had the same success, largely because he had not had the metal as hot as had been mentioned that evening. He would continue his experiments on iron, however, and believed he would get some good results.

The Author's Reply.

M. RONCERAY, replying to the discussion, dealt first with hot metal. Of course, if they were going to use small gates they would have to use hot metal, and he believed they all knew that it was absolutely necessary to use hot metal to have sound castings. If they had not hot metal they would get slag mixed with the metal, and if they had large gates the slag would get inside with the metal, so that there were many reasons for having hot metal and smaller gates. He was rather surprised to hear that there was some iron containing 2.6 per cent. phosphorus; he had never seen it, the common iron used on the Continent contains 1.6 to 0.27 per cent. phosphorus. In Belgium the phosphoric iron was made from the French ore, because they had no ore in Belgium. Discussing the casting of shells, during the war it was not a question of making shells with the phosphoric iron made in France; they obtained hematite iron from England. But that was not the best, he could assure them. Irons of different analyses behave differently, but when the castings shown were made in different shops it would be understood that the analyses were very different. Sometimes they used high phosphorus iron, sometimes low, sometimes low silicon, and sometimes low sulphur, and some of the castings he made himself with only 15 per cent. pig-iron, and with a high phosphorus content. One, he believed, contained 0.26 per cent. sulphur, so that this proves that it was possible to make castings without feeding heads with both high and low sulphur or phosphorus. It seemed to be a matter of adaptation in each case. The brass experiments gave the same results. He could not give his experience with steel, because he had had none, and he did not wish to mention anything he was not sure of. He had heard that if they wanted to get ingots with small pipes they had to resort to slow pouring, and he asked Mr. Darley whether that was so.

MR. DARLEY said it was possible to make an ingot to run on somewhat similar lines from the bottom. His firm made them in their works, ingots of about 2 tons, and there was probably about 4 ins. of pipe in the top only. On the other hand, he had seen the pipe fully half the way down, but by slow running, with a smaller runner, it was possible to run steel with a pipe of only about 4 ins. His firm had a Research Department, and they continued casting ingots and other castings and indexing them, with a view to trying to get over these difficulties. He believed they had got the casting of ingots as nearly as possible with a

minimum of piping, but that was done by having a refractory top pipe. These did not act as chills, because they were put in hot.

M. Ronceray said he had no personal experience of steel, but he believed that something could be gained in this connection, by experimenting on the same lines. It was probably more difficult, because the metal solidifies more quickly; however, the results mentioned by Mr. Creek on chrome nickel steel are striking. With regard to contraction, it seemed that there had been a confusion between what he would call solid contraction and liquid contraction. If they poured metal into a casting and obtained by some way solidification of the mass as a whole, the casting would be sound, but they did not know up to now what was happening before solidification. Solid contraction had nothing to do with the piping. The moment the metal was solid there was no possibility of liquid contraction, and liquid contraction was what made piping. Replying to Mr. Hall, he said that shells had been made in many ways in France, good and bad. The regulation method before the war, was to pour with the heavy part down, and with the feeding head on the top. It was common practice, when this method was adopted, to find a hole in the thick part.

Mr. Hall said that was the way he had cast them, and they were all right, but at Woolwich the heavy side was cast up in the particular case he had mentioned.

M. Ronceray said that was right, and that his opinion was that shells could be made good either way, and had been, in fact, providing good practice was followed. There were many troubles that arose in casting, so that in experimenting they must not expect good results every time, but they must try to change only one thing at a time, in order to avoid assigning the wrong reason to a particular trouble. With regard to the sand Mr. Brown mentioned that in Belgium, France and Germany, sand was more permeable than in England, and at the same time, it was finer, and he (M. Ronceray) could not understand how that could be. Mr. Brown had said that the skin of the castings made in Belgium was smoother. The castings he had spoken about were dry sand castings, and the skin of such castings was produced by the blacking, and consequently has no relation to size of sand. Mr. Melmoth had said he had made the very same casting, *i.e.*, a cylinder liner with success with English sand and English iron. He did not think the English sand was bad, the success of the speakers in many different foundries on many different castings was clear proof of it, but if it were bad, why did not they make it good? If it were not permeable, he suggested putting some silica sand in when milling it. Referring to sulphur segregation and blow holes that Mr. Brown obtained, he thought that the reasons given were altogether wrong.

Sulphur Blow Holes.

Custer made experiments on the influence of occluded air on the soundness of castings, and he found that if, when pouring a casting, the air was trapped with the iron, blow holes were found. There was a combination of the sulphur with the oxygen of the air, producing sulphur dioxide. The same results were found when experimenting in sand and in chills. M. Ronceray again pointed out that the system which was referred to as his system was not his invention, his only aim was to try to throw light on the subject, which was of great interest. He would be proud of the fact that he had lectured to the London Branch if he had been able to interest them sufficiently for them to continue experimenting on the lines he had suggested. It was clearly proved by several experimenters who tried his suggestions, that it was possible to make, under certain conditions, castings without feeding heads, and if it were possible to make some castings, it might be that once they had found the reason for it, it would be possible to make them all in that way.

Votes of Thanks.

Mr. Melmoth proposed a vote of thanks to Mr. Ronceray for his lecture. In doing so, he stated that the subject of the lecture was of infinite interest to him and others interested in the production of steel castings. One speaker had said that he could not see this method being applied to steel, but in his (Mr. Melmoth's) opinion, that was not the attitude to take. He had been connected with the carrying out of an excessive range of experiments on the speed of running steel ingots, and although they were made in chill moulds as against sand moulds in the case of castings, yet they were run from the bottom with a small runner in proportion to the size of the ingot, and his firm had succeeded in dropping their percentage of wasters from these ingots from 25 to 30 per cent., down to 8 to 10 per cent. during the war. A previous contributor to the discussion had referred to the temperature of cast iron. He had never heard of such temperatures as 1,560 deg. C. in cast iron, and he did not see what practical purpose would be served if it were obtained. Also, according to some metallurgical opinion, excessive heat in any metal in the liquid state was liable to leave behind after ill-effects. As to the use of the optical pyrometer, he had not a half-penny worth of faith in any optical pyrometer on the market for judging the temperature of a stream of molten metal. He commented on the fact that the industrial people in this country, who, after all, did count for something, were discussing the technical and industrial problems, whilst the politicians were dealing with more or less abstract and unproductive political questions, and also on a gratifying fact, that it was one of our French allies in the recent War who was teaching them the possibility of this particular method of casting. He himself was going to try to make certain types of steel castings on the lines suggested, and believed one person had already had some success in doing so. He had the greatest pleasure in proposing the vote of thanks to M. Ronceray for his excellent lecture, and the extremely genial way in which he had dealt with the discussion.

Mr. Faulkner, seconding the vote of thanks, said he was rather proud of the fact that he had started the ball rolling. He had given a short account of M. Ronceray's work in the Foundry Trade Journal, and it gave him a feeling of satisfaction to know that one member had derived practical benefit from it.

The vote of thanks was accorded with acclamation.

M. Ronceray, in a brief reply, said he was proud to have received such a warm reception, and emphasised the importance of the exchange of ideas.

Contamination of Air with Carbon Monoxide.—Messrs. Yandell Henderson and Howard W. Haggard, of Yale University, in a contribution appearing in the "Journal of Industrial and Engineering Chemistry," draw the following conclusions from experiments in which the period of exposure was several hours. The time of exposure in hours is multiplied by the concentration of the carbon monoxide in parts per 10,000 of air. If the product equal 3, no perceptible physiological effect is noted; if it equal 6, the effect is just perceptible; if it equal 9, headache and nausea are produced; if it equal or exceed 15, conditions are dangerous to life. Exercise and physical work increase the rate of absorption of carbon monoxide from a contaminated atmosphere. Upon return to fresh air the carbon monoxide which has been absorbed by the blood is excreted through the lungs; from 30 to 60 per cent. of the absorbed carbon monoxide is excreted hourly. Carbon monoxide is the only toxic constituent of importance in the exhaust gas from gasoline. Illuminating gas and the exhaust gas from coal tar distillate contain other toxic constituents as well as carbon monoxide.

The Basset Process.—Speaking at the annual meeting of the Ougrée-Marihaye Company, M. Gustave Trasenster, chairman, mentioned the Basset process, which, he said, had already yielded satisfactory results. The production of a high temperature in a reducing atmosphere, which is the basis of this new process, represented an indisputable progress. The intentions of the directors had been to follow very closely the trials which were being continued, and to secure for the company the exclusive patent rights for Belgium, Luxemburg, and a portion of France. Under these circumstances the Company had considered it advisable to participate in the French company to the extent of 1,000,000 fcs. Among other results obtained with the new process, the speaker mentioned that it had been possible to abstract the metal from the ore, leaving only 1 per cent. of iron in the slag. Certainly the lining of the furnace was not yet what it ought to be, but patience must always be exercised in such matters. If success attended the Basset process the shareholders would have no reason to complain.

XUM

Making Castings without Feeding Heads.

By S. G. Smith.

Being interested in the above subject, dealt with by Mons. E. Ronceray, which appeared in THE FOUNDRY TRADE JOURNAL in the issue of June 1, and the writer having been asked to enlarge upon, confirm, explain, or comment upon its general application in future practice.

Having had to deal with many foundry troubles, difficulties and problems in a large variety of iron castings, it is hoped to approach this matter with an open mind. It is rather difficult to know where to commence and where to leave off. An attempt of this description must necessarily be to some extent exhaustive.

In recent articles, and others which will follow under the writer's name in THE FOUNDRY TRADE JOURNAL, the conclusion arrived at will be that the writer is a strong advocate for feeders and dross heads. Whilst admitting this when necessary, he is not unduly biased if something equally as good can be applied.

Can feeders, feeding heads and dross heads be partially or wholly dispensed with successfully with all or some iron castings? Obviously, it all depends. Starting at genesis, it is generally recognised up to and beyond the fusion temperature of cast-iron there will be to some extent a corresponding expansion in the molten mass according to the temperature reached. If that be true, it will be obvious that the higher the temperature of the molten iron when in the mould, the greater will be the liquid contraction when cooling.

It must be clearly understood that the total weight of a casting is no indication whether that casting requires feeding or not. It is quite possible that a casting weighing 50 tons may require no feeding, and will exhibit no open or porous parts, and yet a casting weighing only 50 ounces may require some precaution to make it sound.

With such a complex mixture as cast-iron, the rise and fall of the temperature from cold to fusion point, and higher to white hot, and downwards from white hot to freezing, and then to cold, many separations, constitutional and volume changes may, and do, occur.

Porosity.

There are three well-known conditions that require some precautions to overcome porosity and segregations: (1) Liquid contraction due to cooling; (2) draws due to thick and thin section of metal in close proximity; (3) where a section or area of a casting is enclosed by an outer section and is kept in a molten condition much longer than all its surrounding parts. At the moment the critical point of the phosphorus eutectic will not be considered, being an accomplice in the formation of draws and cavities.

The only way to produce a sound casting to be free from the defects just referred to is control of the temperature during and after the metal has been poured into the mould, *i.e.*, the solidifying or freezing of the metal in the mould must be uniform throughout the casting. If this can be accomplished by proper location and distribution of small runner-gates, or by the application of denseners, the result will be a uniform-texture casting throughout. But it is obvious this cannot always be obtained even with the best methods of moulding, some of which will be enumerated later.

It is a fact that much molten metal is wasted due to unnecessary risers, feeders, and possibly dross heads, but the commission of the latter sin is very rare.

Another wastage of molten iron, which is deeply rooted in some foundries, is running metal through the off risers after the mould is full. It is quite correct to do this if the mould is blowing, but it is often done from habit alone. The object is, that the metal flowing in through the mould makes for soundness, which is quite erroneous. When a mould is full of metal, nothing moves from the top surface, the flow passes through the runners and under side of the mould to the risers, following the line of least resistance. The metal on the top surface of the mould remains quite still.

Referring at Fig. 7 in Mr. Ronceray's valuable article* which perhaps should be called an hydraulic ram. It was a bold move on the part of anyone to make this casting crown upwards. The writer has made these castings lighter and heavier than this one, but of a more uniform section. The writer is inclined to criticise this design, which he thinks is bad. Why 11 13-16in. of metal on the crown when 4½in. would more than meet all requirements? More metal is wasted in this abnormal thickness than would be required for a large feeding head. Apart from the wastage of weight there is a possibility of a very open-texture metal just where it should be sound and dense. It is not remarkable that a 1¼in. round runner should pour this casting, providing the metal was very hot and fluid. The mould would fill slowly towards the finish, and if the metal was dull it would not fill up to the top of the crown.

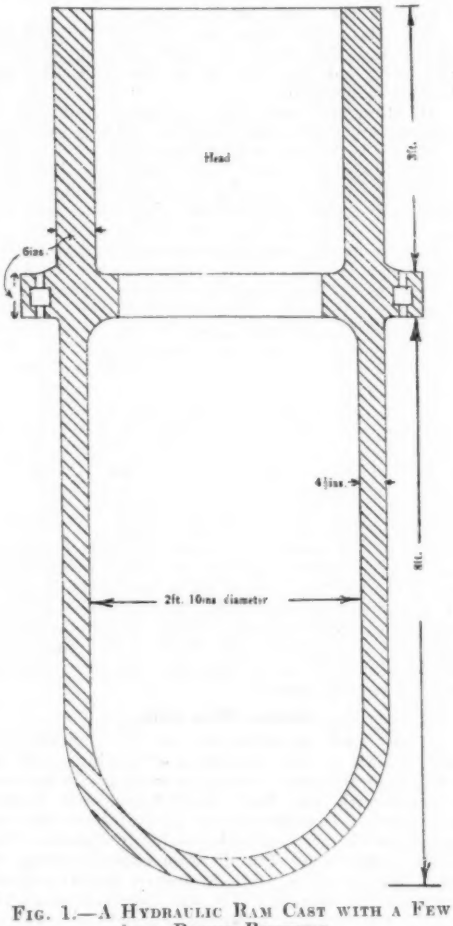


FIG. 1.—A HYDRAULIC RAM CAST WITH A FEW $\frac{5}{8}$-IN. ROUND RUNNERS.

So far as actual weight of the runner is concerned, it is greater than a few small round runners, say, ⅝in. dia., required to pour such a casting from the top instead of the bottom. The article states that the top of the crown came out slightly flattened. Such is to be expected with this method of moulding it, and in all probability if the top crust of the metal of the crown was broken through, open, porous cavities may be disclosed, due, of course, to liquid contraction. The fact that it was put into work without trouble is not conclusive proof of freedom from porosity on such a thick crown. A casting with a flattened crown would not pass inspection in this country, unless some exceptional guarantees were given. Here, such castings must be perfectly water-tight under pressure.

* See page 393, June 1 issue of THE FOUNDRY TRADE JOURNAL.

Hydraulic Ram Considered.

Fig. 1 of this article shows a hydraulic ram as an example of British practice. It was poured by a few ⅛in. round runners on the top. The design of this should be recommended. The abnormal thickness and depth required special attention regarding both area of feeding head, also density of the iron. Referring to Figs. 3 and 4 of Mr. Ronceray's paper and to THE FOUNDRY TRADE JOURNAL of May 18, page 366, which contains a brief article by the writer on Commutator Bushes, Fig. 2 of the latter shows small centre runners through the centre core, similar to Figs. 3 and 4 in Mr. Ronceray's article, but these castings could not be produced perfectly sound and clean without the application of denseners and dross head. The other castings, including the loco cylinders, call for no immediate comment, as it is a matter of hot fluid iron.

British Experiments.

Reference is made to British experiments, but British practice for many years has been when pouring large or small engine liners, vertical cylinders, condensers, and similar castings, to have a small down runner into the bottom of the mould, in order to take a small amount of metal to prevent an excessive splashing when the small top runners are opened. A little feeding is indulged in as a precaution only. The dross head is necessary to ensure a clean top end of the casting. Very large circular castings of great depth and weight are poured with a thin flash-gate ⅛in. thick; also, others are poured with a large number of very small round or flat runners distributed round the periphery. Referring to Fig. 13 of Mr. Ronceray's paper, which depicts a half-coupling, this coupling is poured the same way as the commutator bush in the writer's article just quoted. Considerable trouble has been experienced in producing these castings spotless and sound in bore and body. The way the author has overcome these troubles is shown in an article contained in the FOUNDRY TRADE JOURNAL of May 11, 1922. The writer has not tried the small centre runners in shaft couplings, which vary in weight from a few pounds to twelve cwts. If the small runner contributes to make these castings clean, sound, and free from porosity without chills or feeding, much has been accomplished. We will assume for some castings this may be possible. What is the underlying principle, or law, that is operating during pouring and solidifying? The writer's conclusions at present are that no hidden mystery is involved. The mould poured by small runners to some extent controls the temperature of the metal as the mould is being filled. A very small runner with very hot iron the mould will fill gradually. It will not fill so quickly as a similar mould would with a large runner and the metal of a lower temperature; hence, as the mould is slowly filling, the high temperature of the iron is imparted to the walls of the mould, or, to put it in another way, the walls and cores of the mould are abstracting the heat from the metal as it is filling the mould. Thus, slow filling conduces to an even and uniform temperature of the metal in the mould and contributes to bring the metal to that temperature when it is past the period of liquid contraction; in other words, the liquid shrinkage is taking place as the mould is being filled and the escape of gases is easy. Whether this is partly or wholly the true explanation or not, it is impossible to say definitely, the matter has been put in as few words as possible, and in its support there is ample proof.

Where there are several small runners the metal is being distributed in different directions, and this distribution always balances the even temperature of the metal in the mould. There will be presented in the near future in THE FOUNDRY TRADE JOURNAL a series of articles by the writer dealing with castings failing under water pressure. Under the title of Oil Cooler Castings, sketches will be given of an oil cooler cover. From this it will be clearly seen that the location of the runner in-gates was the solo cause of the porosity. When the runner-gates were altered, which ensured a better distribution of the metal in the mould, the porosity disappeared.

A simple example of how a porous place or spot can be avoided by an altered location of the in-gate will be shown later in an article under the title of Turbine Steam Chests, Fig. 3. In another article dealing with Intermediate Cylinder Heads in Vertical Gas Engines, published in July 6 issue of THE FOUNDRY TRADE JOURNAL, will be found a problem that could not be solved by small runners.

There are limitations to the universal use of small runners with high-temperature metal chiefly owing to design. A number of these are being dealt with by the writer, such as some with areas that cannot be controlled without some form of feeding or the use of denseners.

Dross heads *should not in all cases be considered as feeding heads.* With any system of small runners, precautions must be taken to avoid faint-runs, cold-laps, chilling where machined, and, above all, accumulation of oxides and dust from erosion on the upper parts of the casting as poured.

Institute of Metals.

As previously announced, the Autumn Meeting of the Institute will be held at Swansea from September 19 to 22, by the kind invitation of the Mayor of Swansea and local members of the Institute. The following is the programme:—

Tuesday, September 19.

8.0 p.m.—First Annual Lecture on subjects of practical interest to those engaged in the non-ferrous metals industry. "The Science of Human Effort (Motion Study and Vocational Training)," by Dr. R. S. Hutton, Member of Council.

Wednesday, September 20.

10.0 a.m.—General Meeting in Llewellyn Hall, Y.M.C.A. The Mayor of Swansea, Alderman William Owen, J.P., will open with a brief address. Papers will be presented and discussed.

1.0 p.m.—Members will assemble at the Hotel Metropole, Wind Street, Swansea, for luncheon, by kind invitation of the South Wales Siemens Steel Association, the Tinplate Association, the Spelter Association, the Copper Association and the Swansea Chamber of Commerce.

8.0 p.m.—Civic reception by the Mayor at the Patti Pavilion, Victoria Park, Swansea.

Thursday, September 21.

10.0 a.m.—Resumed General Meeting.

2.0 p.m.—Visits will be made to the following works:—British Mannesmann Tube Company's Works, Landore, Swansea; King's Dock Works of Messrs. Baldwins, Swansea; the Grovesend Steel and Tinplate Company's Works, Gorseinon; Steel, Tinplate and Sheet Works of Messrs. W. Gilbertson & Company, Pontardawe; Works of Messrs. Williams Foster, Pascoe Grenfell & Company, Swansea (spelter, copper and yellow metals); Messrs. Vivian & Sons' Copper Works, Hafod, Swansea; the English Crown Spelter Works, Swansea.

Friday, September 22.

10.0 a.m.—Resumed General Meeting.

1.30 p.m.—Motor tour round the Gower Peninsula, via Killay, Llanrhidian, Cheriton, Llangennith, Burry Green, Reynoldston, Stouthall, Rhossily, and return to Penrice.

New South Wales Steel Workers.—A cable from Sydney states that a conference of employers and employees to discuss the solution of the difficulties facing the reopening of the Newcastle Steel Works has proved abortive, the men insisting that any reduction in wages should be refunded from the profits of the Company.

Russian Manganese Ore for Germany.—According to reports from Kharkoff, the Concession Commission in the Ukraine recently examined various applications from foreign firms for concessions. One leading foreign firm submitted an offer for the leasing of the iron ore mines at Kholaczevskie, in the basin of the Krivoi-Rog, but the Commission refused to grant a concession on the ground that the iron ore mines can only be leased if blast furnaces are operated. The German Mining Association of Essen—the Berg und Hüttenwerke—is reported to have been more successful. After protracted negotiations with the Ukraine Commission in Berlin, the Association is said to have arranged for the annual supply of a large quantity of manganese ore in return for the delivery to the Ukraine Mining Administration of materials for the working of the mines, including cables, pumps, etc. The German Association will only accept the delivery of high-grade ore containing from 40 to 60 per cent.

XUM

American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection with the Finished Product.

By Enrique Touceda (Albany, New York).

(*Continued from Page* 124.)

An Experiment with Steel.

Fig. 12 is a micrograph taken at about 4 dia. of a sample of steel containing 1 per cent. carbon. The sample was placed in a pot, together with the hard-iron castings that were about to be heat-treated, and given the same treatment as is ordinarily given the product of that company. A well-defined pearlitic-ring that is located between the

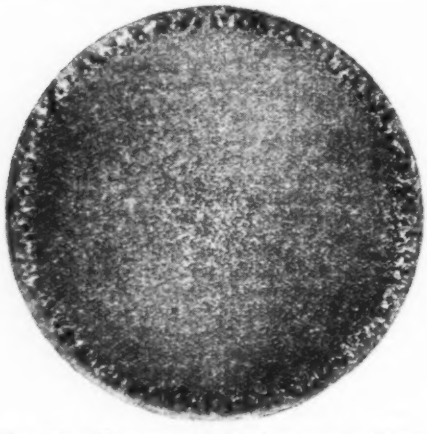


Fig. 12.—Micrograph of a 1 per cent Carbon Steel Subjected to the Same Heat Treatment as Malleable Iron.

surface border and core can be seen, exactly as happens in the case of framed malleable cast iron. There is another kind of frame in which, instead of the pearlite being at the junction of the decarbonised area and the core, it is directly at the surface. This, it is believed, results from a casing-action due to the particular pot-atmosphere existing at the time, and such as would favour the casing of the surface, which condition may be brought about in various ways, particularly when ashes that contain unconsumed coal are used for a packing. The latter condition is the worst form of frame, both from the standpoint of machinability as well as untrustworthiness under shock.

Machining Properties.

It can be stated that the ease with which malleable cast iron can be machined is its most valuable asset, and any defect in the product that operates to retard the speed with which it can be machined is fatal. The two worst defects are the framed-casting, to which reference has been made, and the shrink. Of all of the troubles to which these castings are heir, the shrink is by far the most troublesome and the hardest to combat. Whilst at one time the really-hard casting—the one that was hard throughout, due to an improper heat-treatment—was a source of constant anxiety to the manufacturer, such castings are now rarely produced. It happens, however, that silicon, sulphur, phosphorus, manganese, and carbon all can be present in ideal proportion in a hard-iron casting, and the heat-treatment conducted in an entirely efficient and normal manner, and still castings may under certain circumstances be produced that will have a steely fracture and be hard to machine. Just what operated to bring about such a condition remained a mystery to the author for a long time, owing principally to the fact that in many instances in his experience he found that when it was claimed that all details of works practice had been correctly carried out it was discovered that, unintentionally, he had been misinformed. In the particular case now referred to it was suggested by the management that if this was the author's thought he had better assume the responsibility for a trial air-furnace heat and subsequent heat-treatment. This suggestion was adopted, with the result that, in spite of all precautions, no improvement was found in the fracture. While the author had been acquainted for a long time with the effects of chromium on the structure of annealed castings, he had not suspected until this occasion that chromium was the offender, owing to the supposed rarity of this element in pig-iron in an amount that was in any way harmful; but as soon as it was ascertained that, notwithstanding the fact that every detail of the process had been safeguarded, the castings still were abnormal in fracture, the product was examined for this element, and his suspicions confirmed.

Chromium is Deleterious.

Hard-iron castings, therefore, can be produced by the presence in the mixture of very minute percentages of this element, particularly if the annealing temperature is higher than normal. Not only will less than 1/10 of 1 per cent. produce an abnormal fracture, but this will be accompanied by a phenomenon the explanation of which proved very baffling until quite recently. Some years ago one of the manufacturers was engaged in the production of some railway castings. One of the kilns was poured late in the day, and as the superintendent was anxious to ascertain the quality of the product he broke the test-lug on a number of the castings that were still quite warm, and as the fracture was normal he felt satisfied that all was well. On the following morning the railway inspectors started their examination, and not only did they find that the

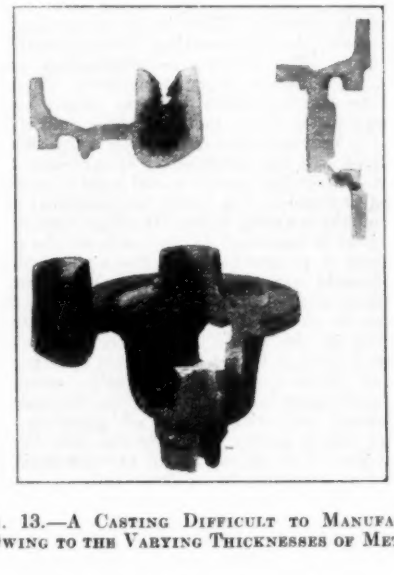


Fig. 13.—A Casting Difficult to Manufacture Owing to the Varying Thicknesses of Metal.

fracture of the test-lugs was steely, but the other test-lug on the castings from which the lugs were knocked off by the superintendent on the preceding day were steely. In the case of these particular castings it appeared as if one end had been properly heat-treated but the other end not. The author was called to the plant, and as there happened to be available some test-bars from this heat that positively could be identified, these were heated to a temperature about 300 deg. Fah. (148 deg. C.), and, when broken, showed a perfectly normal fracture, but when cooled to the atmosphere and again broken the fracture was steely. From this time on a few other cases of this kind came to the author's

attention, but the cause of the phenomenon remained a mystery. Some time ago it occurred to the author that, in view of the curious effects of chromium on the fracture, possibly this element was the cause of this phenomenon also, and without entering into detail as to the complete investigation made, it can be stated that the author has been unable to bring about this condition in the absence of chromium, but that when exceedingly small percentages are present this peculiarity exists. It also appears that the evil effects of chromium are made more manifest the higher the temperature. From the foregoing it appears that at atmospheric temperature the effect of chromium is to embrittle ferrite, while at a somewhat higher temperature—say in the vicinity of 400 deg. Fah. (205 deg. C.)—the ferrite regains its ductility.

Shrink Troubles.

The casting with shrink, however, still persists, although now that the engineer-designer is co-operating with the foundry to a much greater extent than ever has obtained in the past, while everyone in the foundry connected with moulding operations are on their toes in an endeavour to minimise this trouble to the greatest possible extent, it is still with us to an alarming degree. As has been pointed out so frequently in Papers written by the author, shrink not only can prove to be the sole cause for the failure of a casting in service, but even should it occur in a part of a casting that subsequently is to be removed by machining it can cause a damage not suspected by one who is ignorant of the cause. Very early in his investigations the author discovered that, irrespective of how efficient and complete the heat-treatment of a casting might be, free-cementite invariably exists in the area occupied by a shrink,

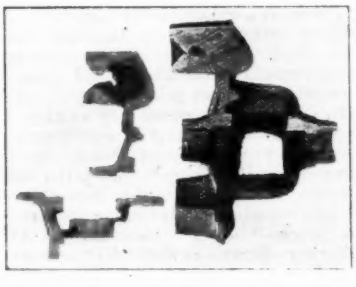


FIG. 14.—OTHER SECTIONS OF THE CASTING SHOWN IN FIG. 13.

that is, wherever a shrink occurs a hard spot will be found. Such hard spots had always been attributed to segregation, with phosphorus as the culprit. Even to-day authors of Papers talk of the liability of segregation, simply because this element is in the vicinity of 0.20 per cent., notwithstanding the fact that for the most part malleable-iron castings will not average $\frac{5}{8}$ in. in thickness of section, and solidify so quickly that opportunity for segregation is denied. While undoubtedly there may have been rare cases of phosphorus segregation, none have ever been called to the author's attention.

Anyone who has seen a Bullard Multiautomatic machine tool at work taking cuts $\frac{1}{4}$ in. thick at 150, and light finishing cuts at 250 ft. per min., machining a casting as fast as the operator can put one in place and remove another that is finished, will appreciate what it means if by chance one of these castings contains a shrink in the path of the tool. The tool set-up on one of these machines cannot be accomplished short of some three or four hours, a loss of time that will not be tolerated. In order that the difficulties of the situation may be appreciated, Fig. 13 is reproduced, showing a casting from which two sections have been cut. One cut is in line with the centre of the head, and through a section of fairly uniform thickness. In the etched section, shown above the casting, it can be seen that there is an entire absence of shrink. About 90 deg. from this another section was machined from a part of the casting whose sections are very disproportionate. The various shrink spots are plainly visible, and to those who have made a study of shrink the cause for their presence should be clear.

This particular casting could be gated and headed in almost any manner, with almost any amount of metal, with little hope for complete soundness in this particular section, while a slight thickening up of the narrow neck, just above the largest shrink, and the removal of some metal from the very-heavy section to which it is attached, would enable the founder to make a solid casting, provided also some slight modification in the case of other sections was made. Fig. 14 refers to a

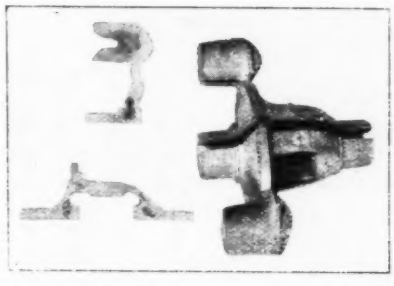


FIG. 15.—FURTHER ILLUSTRATES THE NECESSITY OF REFUSING BADLY-DESIGNED CASTINGS BY THE FOUNDRYMAN.

similar casting, but cut at other sections. Fig. 15 further illuminates this matter, as well as the fact that it is up to the malleable-iron founder to protect himself and his industry by refusing to make castings that are designed in a manner such as actually inhibit soundness. In Fig. 16 is shown the etched section of half of a casting fed by two risers. In this case complete soundness is apparent. In order that the case will be fully understood it should be noted that a strap was also used in this case leading from the heads to the fillet at the neck of the casting, which facilitated and made perfect the feeding at the fillet. The section from A to B is consequently thicker by the thickness of the strap at this point than would be shown in other similar sections of the casting.

For the purpose of making certain deductions in connection with an investigation that it was intended would be introduced in this Paper, and on which considerable work has been done, some bars of wrought iron and soft steel were annealed with malleable iron castings under the usual heat-treating conditions, and in the belief that, although space is lacking to include these experiments, the results of these mechanical tests may be of use to some reader of this Paper in some other connection.

It is unnecessary for the author to encumber the Paper with remarks in connection with the results; they are obvious upon inspection.

FIG. 16.—HALF OF CASTING FED BY TWO RISERS AND MADE SOUND BY THE INTRODUCTION OF A STRAP.

As inferred in the introduction of this Paper, the author has touched upon those questions concerning which he has received inquiry, while he has endeavoured also to avoid dwelling, in so far as possible, upon items that are usually found in papers covering the malleable-iron process. Pressure of work, frequent absences from the city, and other complications have prevented the taking up of a few other items that are, at least, of equal importance to any of which he has made mention, but which owing to lack of time to obtain the samples for illustrations and the making of the necessary micrographs.

In conclusion, the author would state that the future for this industry in the United States is most promising. The manufacturers are deter-

mined that they are going to get all out of the product in the way of tenacity, ductility, and shock resisting properties that investigation and improved apparatus can make possible. Any metal possessing the best machining properties of any ferrous product and having an average ultimate strength exceeding 23.6 tons per sq. in., a yield point approximating 14.75, accompanied by

TABLE I.—*Comparative Tests on Annealed and Unannealed Samples of Wrought Iron and Mild Steel Bars.*

WROUGHT IRON.

Mark	04	05	06	01	02	03
Treatment	U.	U.	U.	A.	A.	A.
Dia.	0.637	0.665	650	0.662	0.657	0.655
Actual elastic limit (tons)	4.6	4.8	4.8	3.5	3.3	3.4
Elastic limit (tons per sq. in.)	14.4	13.3	14.5	10.1	9.8	10.3
Actual ult. strength (tons)	6.7	7.3	7.0	6.4	6.2	6.2
Ult. strength (tons per sq. in.)	21.0	21.2	21.2	18.5	18.4	18.3
Elongation (on 2 in.)	38.0	39.0	39.0	43.5	40.0	42.5
Reduction of area	52.4	51.6	51.2	49.7	50.4	49.2

MILD STEEL.

Mark	44	45	46	41	42	43
Treatment	U.	U.	U.	A.	A.	A.
Dia.	0.665	0.637	0.667	0.651	0.660	0.672
Area	0.347	0.319	0.349	0.333	0.342	0.354
Actual elastic limit (tons)	6.8	6.5	7.2	5.2	5.4	5.9
Elastic limit (tons per sq. in.)	19.8	20.5	20.9	15.5	15.7	16.7
Actua' ult. strength (tons)	10.1	9.4	10.2	8.6	8.8	9.6
Ult. strength (tons per sq. in.)	29.2	29.4	29.3	25.8	25.8	25.9
Elongation (on 2 in.)	41.5	41.5	42.5	43.5	43.5	43.5
Reduction of area	64.6	65.5	65.2	64.6	63.7	63.6

an elongation that easily can be made to average, day in and day out, at least 20 per cent., a figure that to-day is somewhat higher than the average of the American Malleable Castings Association's product as a whole, has a future that is very inviting. The author feels certain that, should British foundrymen enter this particular field in a large way, that Americans will be obliged to look after their laurels as far as quality is concerned. Americans would all welcome the aid and co-operation of the many noted British metallurgists. While very early in the game, and since, the author has experimented with most of the ferrous additions, no results were obtained that have given promise of an improvement of product. All the deoxidisers have been tried, and in no case has any improvement followed their use. It is the American hope that British scientists may in the near future develop some improvement in the process that will serve to make an excellent product still better.

In concluding, the author desires to again thank the Institution for their graciousness in having invited him to be with them as their guest. He also desires to thank the following manufacturers for samples of castings that have been used to illustrate this Paper and for others that were to have been used had time permitted:—Eric Malleable Iron Company, Fort Pitt Malleable Iron Company, Frazer & Jones Company, Marion Malleable Iron Works, Troy Malleable Iron Works, and York Manufacturing Company.

Production of Foundry Coke from Non-Coking Coals.*

BY DR. M. DOLCH.

Various attempts have been made at different times to obtain a satisfactory foundry coke from non-coking coals, among the most important of these being the tests carried out in the United States with "anthracoal" (made with coking anthracite fines with coal-tar pitch). The author is of opinion that only by thoroughly investigating the several reactions that take place when coking coal will it be possible to arrive at a satisfactory solution. A German investigator, Dr. Lierg, recently published an article on this subject of reactions, his consideration being based on the attempt to give non-coking coals the necessary coking capacity by the addition of certain percentages of coal-tar pitch. The trouble when adding pitch for the purpose is that the constituents which go to flux the coal and make it coke escape before the coking temperature of the coal is attained in the coke oven or the retort. This difficulty makes the American process expensive, besides causing a considerable amount of incrustation in the retorts. The present author is of opinion that the binding effect of pitch can be considerably increased if the pitch is added in the dissolved state. Small-scale experiments carried out in this direction, however, cannot be repeated directly on a large scale, because in the latter case the temperature rise is much slower, so that, when the coking temperature is reached, a portion of the cementing medium has distilled out, and is therefore ineffective for the purpose for which it is added. There is no doubt that certain of the bitumens or bituminous substances of high melting point do give a certain facility of coking to non-coking coals.

Tests carried out by the present author and Dr. Lierg proved that it is not only possible to isolate the pitch substances of high melting point from those of low melting point, but also to produce such substances in pitch itself, and consequently to obtain the required products from a substance which is available in practically unlimited quantities. The initial substance used in the experiments was hard coal-tar pitch, this being first of all dissolved in a definite proportion in pure benzene. By filtering the solution and evaporating, there remains a pitch free from any substance insoluble in benzene. This was used as the basis of further tests. By blowing air into this material in the water-bath the desired result was obtained. On taking the pitch so treated and dissolving it in exactly the same quantity of benzene it was found that a portion of the pitch had become an insoluble brown powder on the filter paper. On investigating this insoluble bitumen, and testing its effect as regards increasing the coking capacity of non-caking coal, it was found to behave in exactly the same way as a substance of high melting point obtained by extraction from the coal itself, and also from pitch. The carrying out industrially of this method would naturally depend upon whether it was possible to effect polymerisation on a large scale. To discover the possibility of this, the test was repeated as above, and it was found possible to repeat the process seven times, the residue remaining after "blowing" the pitch being dissolved again in benzene, the insoluble residue filtered, the remaining solution evaporated again, and the pitch "blown" once more. After the seven blowing operations about 90 per cent. of the pitch used at the start had passed into the insoluble form.

From considerations which the author advances, the substances of high melting point would seem to be secondary products of dissociation of pitch produced by the "blowing." The author therefore assumes from repeated tests that the polymerisation of a portion of the pitch is accompanied by its fractionation.

In conclusion, the author considers the possibility of deriving these products from the coal itself, also the nature of certain coking and non-coking coals. The process he is inclined to regard as physical rather than purely chemical, and he states that the properties mentioned may be inherent in certain forms of coal obtained from different geological strata.

The experiments so far carried out show, at any rate, the possibility of using some such process in order to make non-coking coals capable of coking, and even from extracting from the non-coking coals themselves the substances required in order to make them produce a good coke.

* "Glückauf."

Electricity at the British Empire Exhibition, 1924.—The British Electrical and Allied Manufacturers' Association (36 and 38, Kingsway, London, W.C.2) have issued a pamphlet entitled "Electrical and Allied Engineering at the British Empire Exhibition, 1924," explaining what the Exhibition means to Imperial British industry and trade.

British Columbia's Steel Scheme.—A cable from Vancouver states that the Provincial Government will introduce in the autumn Session a Bill to provide a guarantee of $4,000,000 (about £880,000) for the Coast Range Steel Company's bonds for the purpose of establishing the steel industry in British Columbia. The Dominion Government is being asked to guarantee another $4,000,000.

The Development and Manufacture of High-Tenacity Brass and Bronze.

By O. Smalley, M.Inst.M. (Newcastle-on-Tyne).

(*Continued from Page* 121.)

Impurities.

The question of impurities in brass of any kind is problematic. The difficulty is to differentiate between impurities that are harmful and those that are not. Lead, whilst commonly responsible for low-test results, local weaknesses in castings, forgings and stampings due to segregation, patchy appearance of castings and the like, is actually an asset in quantities up to 0.70 per cent., if homogeneously distributed, both cheapening cost and facilitating machining without affecting the physical properties. On the other hand, Sn., Al., Fe., Ni., V. and such special elements of proved value may come under the heading of "harmful impurities," if present unintentionally or incorrectly alloyed. As., Cd., Sb., and Bi. are amongst the most dangerous impurities in brass, but whilst small quantities of these might be harmful singly, they may not be objectionable if in combination with each other or with some other particular element.

Possibly the most objectionable impurity in high-strength brass and one that does not receive the attention it deserves, is Si. In no instance has the author found its presence advantageous—small quantities being conducive to brittleness without conferring any other useful property to compensate for the loss in ductility. It is one of the principal hardeners, and is twice as effective as Al. and ten times that of Zn., weight for weight.

The real value of Si. to the brass founder is as a deoxidant, and should be used in the same way as Mg. and P., which are amongst the best scavengers, but harmful if any remains in the finished alloy. Mg. exerts a similar effect to Si. P., if present in quantities of over 0.15 per cent., causes both blistering and honeycombing.

CO., SO_2, N., H., and various hydrocarbon gases, are present in all brass, sound and unsound. If during melting the charge is overheated or directly contaminated with obnoxious fumes, they are absorbed in excessive quantities, and their evolution on cooling is the principal cause of blowholes in castings.

Problems of Manufacture.

On discussing the manufacture of manganese bronze with the owner of a large brass foundry, he expressed the opinion that the difficulties were such that he did not consider them commercial alloys. This appears to be common experience, yet they are not impossible alloys if the precautions outlined in the first section of this Paper are followed. Certainly Al., Fe., Mn., Ni. and such metals are amongst the most dangerous materials in the brass foundry, and require both a metallurgical knowledge and consummate care in handling, but, apart from these, the actual difficulties of manufacture are no greater than those of ordinary brass.

Melting.—Briefly stated, the principal features to be observed in melting are:—(1) Preparation of suitable stock alloys for the introduction of the more refractory metals. (2) Correct selection of materials; calculating the mixtures from their actual chemical composition, and allowing for melting losses. (3) Carefully weighing out the necessary additions and charging in their correct order. (4) Avoid the use of scrap of doubtful chemical composition, particularly with regard to Fe., Al., Sn., Si. and dross contamination. (5) Melt as rapidly as possible in a neutral or slightly reducing atmosphere, but never superheat more than 20 per cent. of the actual melting temperature and control pyrometrically. (6) Avoid retention in the furnace for long periods after correctly melting. Where this is impossible, carefully control the temperature, cover with a protecting slag, and adjust for Zn. losses. (7) Mix well, but do not oxidise in so doing. (8) Deoxidise with a little phosphor-copper or phosphor-tin just before casting if the alloy contains Mn.; if Mn. is absent, as in the Ni.-Al.-Fe.-brasses, a little copper-manganese is beneficial both as a deoxidant and desulphuriser. (9) Avoid as far as possible contamination with slag in the ladle.

Crucible Melting.—If melted in the crucible, no difficulties present themselves other than those mentioned in the preparation of the development alloys. Despite the high cost in fuel and crucibles, this is still the most commonly used method, and is favoured because of the flexibility of temperature control, the ease of mixing, low melting losses and protection from dirt and obnoxious gases during melting.

At the same time, the open-hearth furnace is of particular value for the manufacture of large castings. Where first cost permits, the gas producer regenerator or recuperator type is recommended. It is flexible, economical and efficient. The coal-fired open-hearth furnace is commonly installed, but it is costly to run, and both the temperature and composition of the metal are difficult of control.

The thermal efficiency of the oil-fired open-hearth furnace works out roughly at about twice that of the ordinary coal-fired air-furnace. Lighters-up, furnacemen, and ash-removers are dispensed with, and flexibility of control of the furnace is a decided advantage. The fierceness of the oil flame is a disadvantage to this furnace, although by the aid of a burner, permitting of accurate regulation of both oil and air and by the used of a good fuel-oil, no trouble should be encountered in this direction.

The common objection to all open-hearth furnaces for the melting of special brasses is the large surface of metal exposed to the furnace gases, which, if oxidising or sulphurous in nature, are injurious. A few logs of hardwood charged during the melting-down period, an occasional shovelful of hardwood charcoal or anthracite coal, and a suitable protecting flux remedy this. The choice of the flux is extensive, but either of the following may be recommended:—(1) Equal parts by weight of plaster of paris and fluorspar; (2) soda ash, 30; fine silica sand, 20; fluorspar, 33; and borax, 17 per cent. by weight. These should be ground down, 2 to 3 per cent. by weight of the charge being sufficient. Melting should not be forced.

Electric Furnace.—This is the ideal melting furnace so far as quality of metal is concerned. With either the direct or indirect resistance or induction furnace melting is almost automatic, Zn. losses and impurity contamination are reduced to a minimum, and melting temperature under perfect control. Unfortunately, electricity is not a commercial fuel in this country, and the crucible resistance furnace—an ideal brass melting furnace—on trial under actual foundry conditions, proved to be costly in both current and crucibles. The induction furnace is flexible, but costly in fuel consumption. The indirect-arc, rocking-furnace appears to be a promising development, but having no working experience, the author can express no opinion.

Scrap.—For high-grade castings only approved scrap should be used. Where the chemical composition is uncertain, and when the metal is either of undesirable form or dirty, it should be run down into pigs. In the recovery of brass swarf, all scrap contaminated with white metal and excessive oxide should be thrown on one side, and the remainder passed through a magnetic separator. If briquetting is possible, 2 to 3 per cent. of borax or plaster of paris should be mixed in and sprinkled with water immediately before pressing. If this procedure is not possible, the swarf should be mixed with 3 to 5 per cent. plaster of paris or 5 per cent. of the No. 2 flux mixture given above, together with a little coal dust, and melting with a reducing flame.

XUM

The objection to the use of fluxes in the open-hearth furnace lined with ganister is the accumulation of slag which banks up the hearth and puts the furnace out of commission. To avoid this, the bottom should be flowed with a suitable flux such as plaster of paris or this material in conjunction with soda ash and fluor spar, according to the nature of the slag.

Removal of Iron.—Iron, existing as an Fe.-rich constituent of lower density than brass, rises to the surface on melting. By using a siliceous slag and an oxidising atmosphere, much of the iron may be oxidised out into the slag as a ferrous silicate.

Removal of Sulphur.—Some protection against this obnoxious impurity is afforded by the introduction of a little NaCl, into the melt. This should be worked in from the bottom, followed by a little Cu.-Mn., which procedure is a safeguard against gas-holes and porosity, common defects of castings made from scrap. With correctly refined scrap of desired composition up to 60 per cent. may be used with safety. Of the ordinary domestic scrap, such as gits, risers and clean overflow metal, no more than 30 per cent. is recommended. All scrap should be tested carefully for Si., As., Sn., and Sb.

Casting.

Ingots and Chill Castings.—Ingot moulds should be short and squat rather than long and thin, and slightly wider at the top than at the bottom. Both ingot moulds and chill moulds should be preheated to a temperature of 37 to 93 deg. C., cleaned with a steel brush and dressed with an organic material. When a clean, smooth skin is desired, a simple tallow or heavy mineral oil dressing is recommended. For general work, a facing of tar followed by a second one consisting of a mixture of dark cylinder-oil of over 205 deg. C. flash point, mixed with powdered charcoal and followed by a dusting of fine charcoal. Polishing-in of black-lead or smoking with burning resin or creosote oil is quite satisfactory for ingots, and does not belch forth the obnoxious fumes and flames common to oil and tar-dressings.

Speaking generally, 10 per cent. superheat is a satisfactory casting temperature, although for heavy ingots it may be reduced to 7 per cent. Top-pouring through a specially prepared runner basin is recommended. A refractory head is an advantage, but not essential, if the caster understands his job. For the manufacture of high-class stampings or sheet, machining the skin of the ingot or slab may be found advantageous.

Green Sand, Dry Sand, and Loam Castings.—The success in the manufacture of any brass casting mainly depends upon the selection of the correct moulding materials and the individual skill of the moulder. There is not time here to detail the preparation of moulding sands and loam, so the problems dealing with such must be reserved for a later date. Briefly stated, the technical properties to be controlled in a moulding sand are:—(1) Bond, *i.e.*, strength; (2) grain size or texture; (3) heat conductivity; (4) refractoriness; (5) permeability and longevity.

Having once established a means to control and standardise the mixtures for the various classes of work, many of the moulder's problems automatically disappear, and the economies effected soon compensate for the initial expenditure necessary. In green sand moulding alone the preparation of synthetic-moulding sand has effected a saving in moulding costs of not less than 20 per cent.

Conditions governing the choice of mould-green, dry sand or loam, and the general principles of moulding, are very similar to those of ordinary brass-castings, and call for no special comment.

Gating and Feeding.—Without doubt this is the cardinal problem of the moulder. Wrong gating and feeding are responsible for more defective work than any other operation in the foundry. They call for an elementary knowledge of both physics and mechanics, together with practical experience—without which it is impossible to make a commercial casting, *i.e.*, a good quality casting for the minimum expenditure of time, labour and materials. It is folly to attempt to lay down hard and fast rules, as almost every class of casting presents its own difficulties. The principal points to be observed in gating and the fixing of risers are:—

Gits.—(1) *To fill the mould so that the stream of metal is continuous and not broken up on entering the mould.* Wherever possible, run from the bottom or on the level with a good head. This is particularly important in brasses containing aluminium and manganese, which must be cast under the exclusion of air as far as possible. (2) To prevent dross from entering the mould. For flat, circular castings a whirl gate is preferable; for cylinders and the like run from the bottom by means of a series of tangentially cut "V" shaped jets, and for general castings, an ordinary skim gate. (3) To arrange for a straight run of the metal and to avoid direct contacting on delicate cores or projections in the mould. Avoid sharp angles at turning points.

Feeding.—(1) Mould in such a way that the heavy sections are placed in the upper part of the mould. (2) Connect the heavy sections, which are shut off from the lighter sections, to a good feeding riser, by a section of increasing dimensions. (3) Use chills on the thicker sections to equalise the rate of cooling. (4) Use risers or flows of conical form appreciably larger at the top than the thickest section of the job. (5) Place risers at the highest point of the castings and directly above the thickest sections. (6) It is false economy to cut down the number or size of the risers and small dummy risers should be placed where dirt is likely to be trapped. (7) Risers should be filled preferably with hot metal from another ladle or crucible. (8) Where rod feeding is necessary, choose the right section of rod and pre-heat before immersing.

Pouring Dishes.—These should be designed so that bottom pouring is always obtained, so preventing the entrance of scum into the mould. To this end, deep pouring dishes and cast-iron plugs are an advantage. For large important castings, the pouring dishes should hold at least ½ the weight of the casting.

Pouring.—In the final operation of pouring, the first and foremost factor controlling the production of sound castings is the selection of the correct casting temperature from the dimensions and requirements of the job. Never cast with under 6 per cent. superheat nor over 15 per cent.

The casting temperature of these alloys usually range between 930 deg. C. to 1,030 deg. C., according to the chemical composition, etc. The actual casting temperature, however, is best found from Fig. 1, adding the desired percentage of superheat to the melting-point figure. For actual foundry use, small quantities of special metals (under 0.5 per cent.) need not be taken into account. Exceeding this amount, they should be calculated back into either their Cu or Zn equivalents. When the alloy is complex an actual freezing temperature determination is the only satisfactory method. If cast with metal on the cold side, short runs, low strength, brittleness, drawing, blowholes, cracks and mechanically contaminated oxide are the principal defects encountered. If too hot, honeycombing, wrong composition, poor physical tests, weak crystal zones and segregation. Whilst absolute control of casting temperature is appreciated by all founders, there are few who actually measure it from day to day. This may be attributed to the want of a reliable instrument. To anyone interested in foundry pyrometers, the author would refer them to a Paper given by J. Arnott (Proceedings B.F.A., August, 1920), and a Paper read to the Newcastle Section of the Institute, March, 1922.

In concluding, the author desires to express his thanks to the directors of Sir W. G. Armstrong, Whitworth & Company, Limited, for their permission to publish this Paper, particularly to Sir G. Hadcock, F.R.S.; also to recognise the invaluable assistance and advice rendered by Mr. Homfrey, chief of the Brass Department, and to thank Mr. Adam for his kind indulgence, encouragement and keen interest evinced throughout.

The directors of the Clyde Valley Electrical Power Company, Limited, have declared an interim dividend on the ordinary shares of 2½ per cent. (actual).

Some Notes on Belgian Foundry Practice.

Our representative recently had the opportunity of visiting some of the larger foundries in the Liège district, and was impressed with the efforts made to effect economies and to produce sound castings.

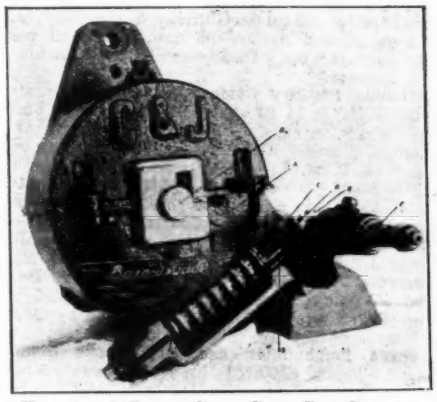


Fig. 1.—A Ladle Gear Case Cut Open to Show its Internal Mechanism.

In the foundries of Esperance-Longdoz, of which Mr. Varlet is the manager, a considerable economy was effected in the manufacture of ingot moulds, as the heat evolved by the cooling castings was employed to dry the moulds for the next batch. Thus, the drying of the ingot-mould moulds was effected for a mere depreciation price of a simple installation. In the same foundry, some of the hot gases leaving the large drying stove are utilised to dry all the moulds and cores for the brass foundry which is situated on a floor above, the stove of this department being built over a portion of the mould-drying oven.

The moulding times outlined in Mr. Varlet's paper on Loam Moulding in the Province of Liège were confirmed by our representative, and were even thought to be very conservative estimates. There appears to be much attention given to the question of pouring speeds and entrained slag, with which questions one naturally associates ladle design. In the Cockerill foundries our representative noted a bottom-pouring ladle being used for cast-iron, a loam stopper being used instead of the usual fire-brick variety. This, however, was only being conducted on an experimental scale. The ladle, however, which found most favour is one manufactured by Mons. A. Collin, of 60, Rue des Champs du Mont, Ougrée-Liège. In this type of ladle the designer has installed roller and ball bearings running in oil. Now this necessitates that the bearings,

Fig. 2.—A Modified Ladle Gear Case for Use with Large Ladles.

and especially the oil, should be kept cool, to prevent seizing in the former case and carbonisation in the latter. The method adopted has been to incorporate an air cushion in between the ladle shell and the gear-box. A gear-box, cut open, is shown in Fig. 1, from which it will be noticed that a gear-wheel (a) is attachd to the axle of the trunnion (b), which is actuated by a worm (c). This is geared up by means of the pinions (d) and (e) to the turning wheel spindle (f). The worm runs in roller bearings (g) and the ball-bearings (h). The whole is totally enclosed and runs in a good-quality machinery oil-bath. The inventor claims that all torsional motions are taken up by the sliding cover. The object of placing the worm at the angle shown is to facilitate lubrication. For the larger ladles, two worms are used as shown in Fig. 2. The special problem of a geared foundry ladle is that it must run smoothly amidst dirt and heat. Obviously the enclosing in an oil-bath has eliminated the dirt question, but to have gearing running in oil a few inches from liquid metal required some further consideration. Primarily, most ladles being slightly conical in the vertical sense, are provided with tightly-fitting belts of similar form. Now the expansion of such a belt would cause the axis of the trunnion to be deformed, and the gearing to seize or work stiffly at its normal working temperature, though it may turn freely when cold! Mr. Collin therefore incorporated a true cylinder for the belt, and separated it from the body of the ladle by an air-gap as is shown in Fig. 3, thus eliminating the dual trouble of unequal expansion and the overheating of the gearing. Our representative saw a ladle of this type at work in the Cockerill foundries, and

Fig. 3.—A Ladle of 20 Tons Capacity. It is Provided with an Air-cooled Cylindrical Belt for Preventing the Overheating of the Gears and Oil Bath.

was impressed with the ease with which it could be manœuvred. The turning wheel is quickly detachable and the mechanism for locking the ladle in the vertical position is a neat automatic device showing much advantage over the fork usually employed. The stream could be regulated with the ease of a water tap, the absence of back lash being particularly noticeable. The system has been covered by patents throughout the world, the British specification being numbered 175,234.

Although the system has only been on the market a very short time, about 100 have already been sold, including three for the Llanelly Foundry Company.

Another innovation noticed in the Cockerill foundries was an oil-fired cupola. This was said to be a distinct technical success, but it had not been installed sufficiently long to say definitely whether it showed sufficient economies to be a commercial proposition.

Mr. James Walton, M.P., commenting on the Amending Bill to the Trade Unions Act, which passed its second reading on May 19 by a substantial majority, remarks that if we have arrived at a time when trade unions attempt to bind their members in political matters, it obviously becomes necessary to adopt means whereby political freedom can be obtained and maintained. This can and ought to be done without the slightest desire or necessity to injure or smash trade unions in the process.

XUM

Trade Talk.

Crossley, Jacob & Gee, Limited, have removed to 8, Lambeth Palace Road, London, S.E.

Mr. Leonard Railton has removed his offices to 1, Dowlais Chambers, Bute Docks, Cardiff.

Boucher & Company, engineers, etc., have established a branch at Green Street, Kidderminster.

Ewart Wells & Company, steelworks' engineers, have removed to 62, Holborn Viaduct, London, E.C.

The British and Foreign Metal and Chemical Company, Limited, have removed to 9, New Broad Street, E.C.2.

Wakelins, Engineers, Limited, have acquired the business of the Snercold Engineering Company, Limited, Hampton Wick, Middlesex.

At the meeting of representatives of the Welsh Siemens Steel Association and the A.E.U., under the chairmanship of Mr. George Rowe, to deal with a request for improved conditions, after a discussion an arrangement was effected.

Lithgows, Limited, of Port-Glasgow, intimate that they are prepared to lay down four large cargo steamers in their yards if their workmen will accept pre-war rates of wages, plus any bonuses and advantages to which they and other workers may be entitled.

Meldrums, Limited, Timperley, near Manchester, have taken orders during June for fuel economy apparatus as follows:—17 orders for forced draught furnaces, including collieries, gasworks and engineering firms; one order for stokers, and five orders for destructors.

The South Wales Joint Steel Board met at Swansea last week, when a wages agreement was entered into for the next three months. A graduated scale was agreed to, under which the lowest paid men will receive a bonus of 40 per cent. and other employés lesser amounts.

In consequence of the slightly reduced costs of production, Henry Wiggin & Company, Limited, of Birmingham, announce reductions in the prices of their "Ferry" resistance wires, and "Glowray," "Redray" and "Brightray" nickel chromes for cooking and heating apparatus.

Palmers Shipbuilding & Iron Company, Limited, of Jarrow, have secured a contract for the building of a special type of cargo vessel, together with the twin-screw engines, with passenger accommodation, of 7,000 tons deadweight, for London owners. The firm have also secured orders for machinery for two oil tankers to be built on the Wear.

As the outcome of a visit paid to the site of the British Empire Exhibition at Wembley Park by a party including many of its leading members, a movement was set on foot at Lloyd's, which has resulted in the munificent contribution of £100,000 to the Guarantee Fund of the Exhibition, which now amounts to more than £1,150,000, and will, it is hoped, reach £2,000,000.

John G. Kincaid & Company, Limited, Greenock, have secured an order to supply a set of six-cylinder Burmeister and Wain-Harland and Wolff type of Diesel engines capable of developing 1,350 b.h.p. for a new vessel to be built on the Clyde for British owners. They have also secured an order for another set capable of developing 1,900 b.h.p. This latter set is for a leading firm of Spanish shipowners.

The monthly ascertainments, under the sliding scale by which the wages of blastfurnacemen in Cumberland and North Lancashire are regulated, shows that the average selling price of West Coast Bessemer mixed numbers for July was £4 18s. 8d. per ton, or a reduction of 2s. 9d. per ton compared with June. The wages of blastfurnacemen in West Cumberland and North Lancashire are accordingly reduced by 3½ per cent. to 35½ per cent. above standard.

The proposals for the closer co-operation amongst the leading engineering institutions have now received the approval of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institution of Electrical Engineers. An Engineering Joint Council, composed of representatives of these bodies, has been formed. Among the objects of the Joint Council will be the improvement of the status of engineers, securing the better utilisation of their services in the country's interests, the appointment of properly qualified individuals to responsible engineering positions, and the prevention of unnecessary duplication of activities.

Australia and Germany.—A cable from Melbourne states that Australia has officially resumed trading with Germany, but the proclamation prohibiting the entry of goods from ex-enemy countries without the consent of the Minister of Customs will not be revoked at present.

Company News.

Astro Electric, Limited, Carlton House, Lower Regent Street, London, S.W.18.—Capital £20,000 in 15,000 9 per cent. cumulative participating preference shares of £1 and 100,000 ordinary of 1s.

Austin, McGillivray & Company, Limited, Falcon Steel and File Works, Napier Street, Sheffield.—Capital £5,000 in £1 shares, to acquire the business carried on by Austin McGillivray & Company, manufacturers of and dealers in iron, steel and metals, files, forgings, etc. Directors: E. N. Gamble and G. L. Roberts.

Britannia Foundry Company, Limited, Coventry.—Capital £10,000, in £1 shares; to acquire the business formerly carried on by the late A. P. Smith as the Britannia Foundry Company, and to adopt an agreement with P. G. Loveitt.

Butterworth & Company (Glasgow), Limited.—Capital £2,500 in £1 shares. Electrical engineers.

Consolidated Electrical Company, Limited.—Net profit, £3,476; brought forward, £1,015; available, £4,491; dividend, 2 per cent.; carried forward, £1,381.

Controla Engineering Company, Limited, International Exchange, Birmingham.—Capital £1,750 in £1 shares; to acquire the business carried on by Controla Engineering Company (in liquidation).

Irvine's Shipbuilding and Dry Docks Company, Limited.—Profit, £100,764; brought forward, £13,687; available, £114,451; amortisation on leasehold buildings and depreciation, £9,996; income-tax, corporation tax and directors' fees, £39,303; balance, £65,152; dividend on preference, £24,000; carried forward, £41,152.

Killamarsh Steel & Tool Works, Limited, Sheffield.—Capital £1,000.

Knighton Electric Supply Company, Limited, 6, Broad Street, Knighton, Radnor.—Capital £6,000 in £1 shares.

Milners' Safe Company, Limited.—Dividend 10 per cent. per annum, less tax, for year.

Motors, Machinery & Metals, Limited, Chiswick Park Works, Kent Road, Acton Green, W.—Capital £5,000 in £1 shares.

Pickvance, Limited, 41a, Regent Street, Wrexham.—Capital £5,000 in 3,000 ordinary and 2,000 preferred shares of £1. Engineers.

E. Pulbrook & Company, Limited, 52, Leadenhall Street, London, E.C.—Capital £5,000 in £1 shares. Engineers.

Richard M. Lord, Limited, 45, Cherry Street, Wolverhampton.—Capital £1,000 in £1 shares; to adopt an agreement with F. C. French, and to carry on the business of safe makers, founders, etc.

Spauls, Limited, Castle Hill, Norwich.—Capital £6,000 in 5,000 5½ per cent. cumulative preference and 1,000 ordinary shares of £1. Engineers.

George F. Sugden & Company, Limited, 9, Albert Square, Manchester.—Capital £5,000 in £1 shares. Engineers.

Tilly & Brown, Limited, 7, Castle Street, Farnham.—Capital £20,000 in £1 shares. Tool makers.

Turnbull & Company (Metals), Limited, 2, St. James's Street, Derby.—Capital £1,000. Metal merchants. Directors: J. Turnbull and F. E. Tapping.

H. G. L. Young, Limited, 1a, Upper Hollingdean Road, Brighton.—Capital £2,000 in £10 shares. Engineers, etc. Directors: H. G. L. Young (managing) and H. T. Bailey.

Westminster Electric Supply Corporation, Limited.—Interim dividend, 9 per cent. per annum.

W. T. Henley's Telegraph Works Company, Limited.—Interim ordinary dividend, 5 per cent.

Wilson Hartnell (Installations), Limited, New Station Street, Leeds.—Capital £100 in 1s. shares. Electricians, mechanical and electrical engineers, etc. Directors: R. D. Fairclough and W. D. Oddy.

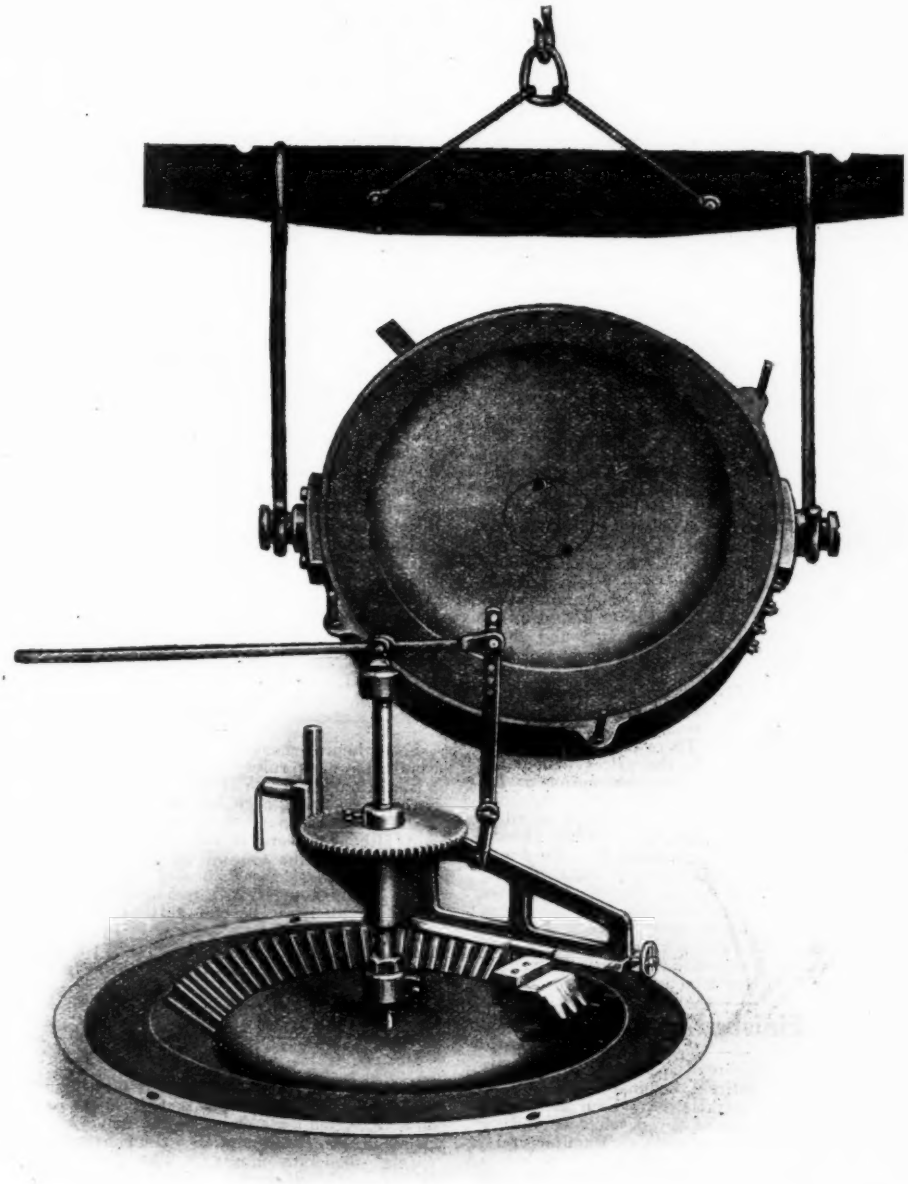
Deaths.

Mr. H. G. Walker died last week at Ednam House, Dudley, in his eighty-seventh year. The deceased, who took a very prominent part in the public life of Dudley, was the son of Mr. Henry Walker, of Netherton. He founded the firm of Walker Brothers, galvanisers and constructional engineers, of Wales.

Mr. J. B. Tompkin, of Brooklyn, Clarkgrove Road, Sheffield, has died suddenly at the age of 75 years. He had been in failng health for some time. Mr. Tompkin was the governing director of Flockton, Tompkin & Company, Limited, Newhill Steel Works, Sheffield, and much of the success of the firm had been due to the business ability of Mr. Tompkin, who was held in high esteem by all the staff, as well as by a large circle of friends.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,
(MANCHESTER), LIMITED,
BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

The month of August, in the most active times, is always regarded as a quiet period in the pig-iron trade, and on this occasion has so far upheld the tradition, market movements having practically ceased with but very faint prospects of an early development in the opposite direction. In South Staffordshire, though the usual weekly meeting at Birmingham was held, business was virtually at a standstill, consumers showing little disposition to buy, while, on the other hand, makers were not pressing sales in a weak market. The demand for foundry iron anticipated in this district, has proved disappointing, the expansion of trade hoped for following the end of the lock out not having materialised. There is, however, a somewhat improved market for forge iron, which it is expected will expedite an increased production before the autumn. On Tees-side, home demand for Cleveland iron has not yet recovered from the holiday idleness, with business still on a limited scale, conditions considered likely to obtain during the current month. The depression has been accentuated of late by the collapse of the German exchange, and its consequent effect upon other Continental money markets, with the result that Belgium has again become a competitive factor in the home trade. Some compensation may be admitted in the shape of a heavy volume of inquiry from the United States, which, during the continuation of the miner's strike has become a substantial purchaser of Cleveland iron. This movement may, however, be only of temporary duration, and Cleveland pig-iron makers are quite alive to the inadvisability of undertaking extensive contracts subject to the termination of the strikes across Atlantic. Considering the recently conceded freedom of markets, prices for Cleveland iron retain remarkable steadiness, No. 1 foundry still commanding 95s. per ton, with No. 3 G.M.B. on offer at 97s. per ton, and lower grades quoted respectively at round about 85s. for No. 4 foundry, 83s. for No. 4 forge, and 80s. for mottled and white.

In the East Coast hematite market business continues quiet, though a partial revival of the steel industry is expected to have results favourable to an early expansion of demand. There is now, it will be noted, very little difference in the prices quoted for mixed numbers whether for home consumption or for shipment abroad, buyers in the first-named category being in a position to purchase at 90s., with an additional premium of 6d. for No. 1 quality. These favourable terms are attracting more attention from the South Wales steel makers, while a few parcels are also going for shipment to Italy. In the north-west area there are heavy stocks of hematite accumulated to the extent of between 60,000 and 70,000 tons, which makers are anxious to dispose of, but even with this large quantity on hand there is little pressure to sell below the current rate of 105s. for Bessemer mixed numbers.

Finished Iron.

Movements in all sections of the finished iron trade this week have been entirely dominated by holiday influences, and where markets have been held there has been a complete absence of any developments likely to affect future business prospects. Manufacturers, with very few exceptions, have suspended operations for the annual vacation, and meantime prices for finished material have been left unchanged. A general impression, however, prevails that the downward tendency is only temporarily checked, and that on the resumption of more active conditions, the levelling-down process will make further progress, the recent reduction in labour and rail freights costs encouraging buyers to anticipate some movement in that direction. Consequently pressure is being exerted to exact more favourable terms from sellers, and with order books as a rule in a depleted condition, it appears as though drastic revision of current quotations for all classes of finished material must be regarded as inevitable in the near future. For the present, therefore, prices remain stationary, but as far as firmness is concerned this qualification only applies in the case of marked bars, for which there is perhaps a slightly better demand than in the case of the commoner grades of iron, in which Continental competition continues as an active factor in controlling home quotations.

Steel.

On all sides there are at last welcome signs of a gradual revival of buying interest in steel and its products, accelerated probably by the restoration of free trade conditions in connection with the home markets by the recent decision of the Associated Makers, who have now abandoned the fixed minimum price schedule, which will mean, of course, an immediate readjustment of prices on a lower scale. So far as can at present be ascertained, this will mainly apply in the case of sections which, it appears, are now quoted at a maximum of £9. No corresponding reduction in the item of extras has yet been announced, and as these charges form a substantial addition to the total cost of material, it is quite consistent that buyers should expect some concession in this direction. At Sheffield, the volume of overseas inquiries continues favourable to an expansion of business, while in many branches of the steel industry specially catering for the foreign markets, heavy steel trade prospects are brighter; but the crucible branch, and more especially high-speed steel, still remains slack. The rush of high-speed steel deliveries to the States is now about over, and the impression prevails that the new tariff proposals will shortly become law, in much their present form, and there is consequently no time left to get further orders across within a reasonable margin of time. Travellers returning from the States report diverse views on the new tariffs, but the general idea seems to be that while the majority do not want them they will be duly passed by the Senate on much the same lines as the passing of prohibition.

Scrap.

Transactions in all kinds of scrap metal during the past week have been on a restricted scale in the Cleveland market, but in the case of heavy steel the demand is slowly but steadily increasing, with prices fluctuating between 62s. and 63s. per ton, delivered at works. There are distinct indications that a scarcity of suitable material is being felt throughout the district. Turnings and borings are in fairly good demand, but only limited supplies will be available until the engineering works resume active operations. Cast-iron machinery scrap is in poor demand on the North East Coast, and nominal prices remain unchanged at £3 17s. 6d. per ton. Prices for heavy wrought-iron, all classes, remain stationary, the demand being almost non-existent.

Tinplates.

Some improvement may be noted in the general conditions now ruling in the tinplate market, but business on the whole is quiet and uneventful. The lower prices ruling have, however, induced a good many buyers to make purchases, mainly for spot delivery, and although there is not a great deal of forward trade reported the tone all round is distinctly better. The standard size was done at 19s. 6d. for August, 19s. 4½d. for September, 19s. 3d. being taken here and there for delivery beyond this. Current quotations may be called :—Coke tins, I C 14 by 20, 112 sheets, 108 lbs., 19s. 4½d. to 19s. 6d. per box; I C 28 by 20, 112 sheets, 216 lbs., 38s. 10½d. to 39s. 3d. per box, net cash, f.o.b. Wales.

Metals.

Copper.—An easier tendency has mostly ruled in the week's standard copper market, business having been on a restricted scale owing to the holidays, while purchases on home consumption account have been reduced within moderate limits. The Continent, also, is taking only small parcels to meet present requirements, any expansion of buying in that direction being restrained by exchange difficulties. Labour troubles in the States restrict consumption for the time being, but it is anticipated that a settlement of the dispute would be immediately followed by a substantial demand, for which the stocks at present available are likely to be inadequate. Current quotations :

Cash : Wednesday, £64 12s. 6d.; Thursday, £64 2s. 6d.; Friday, £64 2s. 6d.; Monday, £64 2s. 6d.; Tuesday, £63 17s. 6d. *Three Months*: Wednesday, £64 15s.; Thursday, £64 5s.; Friday, £64 5s.; Monday, £64 5s.; Tuesday, £64.

Tin.—The position in the standard tin market during the current week has disclosed few features of outstanding importance. Values have fallen considerably, owing to the withdrawal of influential support from the market and a temporary decrease in consumptive demand. The latter may be explained by the fact that the Welsh tinplate mills are idle from holiday reasons, conditions likely to exist until the inflow of autumn orders materialises. Sales in the Eastern markets are now in more moderate volume and are reported at rather lower figures than have prevailed of late. Current quotations :—

Cash : Wednesday, £160 2s. 6d.; Thursday, £159 2s. 6d.; Friday, £158 10s.; Monday, £158 15s.; Tuesday, £158 17s. 6d. *Three Months*: Wednesday, £160 5s.; Thursday, £159 7s. 6d.; Friday, £158 15s.; Monday, £159.

Spelter.—Values of this metal are firmly maintained, and so far market movements indicate a further steady appreciation, due to limited supplies, and abnormally reduced stocks in the States. Continental producers are reported well booked and are apparently indifferent to offers of forward business. Current quotations :—

Ordinary: Wednesday, £31 10s.; Thursday, £31 5s.; Friday, £31; Monday, £31 5s.; Tuesday, £31 5s.

Lead.—Only a quiet business is passing at the moment in the market for soft foreign pig, with prices showing a declining tendency. Stocks in hand are at a low level, the figures for the end of July standing at 235 tons, as compared with 268 tons at the same period in June. Current quotations :—

Soft foreign (prompt): Wednesday, £25 12s 6d; Thursday, £25 7s. 6d.; Friday, £25; Monday, £25 5s.; Tuesday, £25 5s.

Book Review.

INDUSTRIAL UNREST: A WAY OUT, by B. Seebohm Rowntree. Published by Messrs. Longmans, Green & Company, Limited, Paternoster Row, London, E.C.4. Price 1s. net.

The author of this little book has set out to show that industrial unrest can be cured by the application of various schemes having for their end the amelioration of the workers' position. As the book is somewhat of a political nature, it is beyond our province to express any views on its merits or demerits.

MESSRS. AUGUST'S MUFFLE FURNACES, LIMITED, of Thorn Tree Works, King Cross, Halifax, have recently received three repeat orders and five new orders for their standard patent muffle furnaces, for heat-treatment, normalising, annealing, and case-hardening, and a very large order for a battery of eight of their various types of core and mould drying ovens from one of the largest textile machinery manufacturers in the country.

MISCELLANEOUS.—*Continued from p. 18.*

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. ADAMSON, Ushaw Moor, County Durham.

FOR SALE.—LOAM MILL, 4 ft., Pan first-class order, £30; 1- and 2-cwt. Ladles, 2 Cupolas for 2 and 4 tons per hour; Foundry Travelling Crane, 16ft. span, to lift up to 4 tons. £50; quantity Grinding Wheels from 3 in. up to 40 in. diam.; new.—GEO. DEAN, Engineer, Vulcan Street, Cobridge, Staffs.

THE PROPRIETOR OF BRITISH PATENT No. 127462, dated August 13, 1918, relating to "MATERIAL CONVEYORS FOR FURNACES," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

THE BRITISH CAST IRON RESEARCH ASSOCIATION.

Appointment of Director of Research.

The Council invite applications for the post of Director of Research of the Association at a commencing Salary not exceeding £900 per annum, according to Scientific attainments, and Foundry, Blast Furnace or other suitable Industrial experience.

Forms of application can be obtained from the undersigned, which are to be returned on or before August 31st, 1922.—THOMAS VICKERS, Secretary, Central House, New Street, Birmingham.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

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Phoenix Works, Penistone NEAR SHEFFIELD.

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PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	17	6
Three months	64	5	0
Electrolytic	70	0	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	5	0
Do. Aug.	71	5	0
Do. Sept.	71	5	0
Ingot bars	70	10	0
H.C. wire rods	76	0	0
Off. aver. cash, July 63	3	7 3/4	
Do. 3 mths., July 63	10	5 1/4	
Do. Settlement July 63	3	2 1/4	
Do. Electro, July 71	0	0	
Do. B.S., July 67	0	0	
Aver. spot price, copper, July 63	2	6	
Do. Electro, July 71	13	7	

Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10½d.
Yellow metal rods	6½d.
Do. 4x4 Squares	8½d.
Do. 4x3 Sheets	9½d

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13d
Rods, drawn	10½d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9½d.
Rolled metal	9½d.

TIN.

	£	s.	d.
Standard cash	158	17	6
Three Months	159	0	0
English	158	15	0
Bars	160	10	0
Chinese	157	10	0
Straits	159	15	0
Australian	159	7	6
Eastern	159	10	0
Banca	158	12	6
Off. aver. cash, July	156	4	4½
Do. 3 mths., July	156	14	5¾
Do. Sttlment. July	156	4	2
Aver. spot, July	156	3	7

SPELTER.

	£	s.	d.
Ordinary	31	5	0
Remelted	30	0	0
Hard	23	10	0
Electro 99.9	35	10	0
English	31	15	0
India	24	0	0
Prime Western	31	7	6
Zinc dust	48	0	0
Zinc ashes	9	0	0
Off. aver., July	28	18	5½
Aver., spot, July	29	0	10½

LEAD.

	£	s.	d.
Soft foreign ppt	25	5	0
English	26	0	0
Off. average, July	24	6	11¼
Average spot, July	24	17	4½

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	37	10	0
Dutch	37	10	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

	£	s.	d.
English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 7 6 to 11 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
45/50%	12	17	6
75%	22	0	0

Ferro-vanadium—
35/40% 17/6 to 17/9 lb. va.

Ferro-molybdenum—
70/75% 6/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% 1/8 lb.

Ferro-chrome—
4/6% car. £24
6/8% car. £23 10
8/10% car. £23

Ferro-chrome—
Max. 2% car. £60
Max. 1% car. £70
Max. 0.70% car. £78
67/70%, carbonless 1/7½ lb.

Nickel—99%, cubes or pellets £150

Cobalt metal—98/99% 10/6 lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% 5/- lb

Ferro-manganese (net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb,
Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	3	10	0	3	15	0
Bundled steel & shearings	2	17	6	3	7	6
Mixed iron & steel	2	19	0	3	7	6
Heavy cast iron	3	5	0	3	15	0
Good machinery for foundries		4	0	0		

Cleveland—			
Heavy steel	3	2	6
Steel turnings	2	5	0
Cast-iron borings	2	5	0
Heavy forge	3	12	6
Bushelled scrap	3	2	6
Cast-iron scrap	3	17	6

Lancashire—			
Cast iron scrap	4	0	0
Heavy wrought	3	10	0
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	31	0	0
Lead (less usual draft)	21	0	0
Tea lead	19	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	47	0	0
Gun metal	41	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/-
Foundry No. 3	87/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	100/-
„ No. 3	95/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	101/2
W.C. hematite	104/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
„ foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	112/-
Glengarnock foundry	114/6
Gartsherrie foundry	114/6
Monkland foundry	112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£11 to 11	10	0
Tees to 3 united ins.	£11 10 to 12	0	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	2	6
Bolts and nuts, ⅜ in. × 4 in.	19	10	0
Steel—			
Ship plates	9	0	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	8	12	6
Tees	9	12	6
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	10	10	0
Rounds, under 3in. to ⅜in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1¼in.	8	10	0
Rails, heavy	9	0	0
Fishplates	14	10	0
Hoops	11	15	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	5	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ¾ in. dia	14	0	0
Billets, soft	7 0 0 to 7	5	0
Billets, hard	8	0	0
Sheet bars	7 5 0 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.76
No. 2 foundry Valley	28.00
No. 2 foundry, Birm.	18.50
Basic	26.96
Bessemer	26.76
Malleable	28.96
Grey forge	27.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.02
Steel bars	1.70
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.70
Skelp, sheared steel	1.70
Steel hoops	2.50
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv.	3.05
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
„ furnace	30/-
Durham & North. foundry	28/-
„ furnace	23/6
Other Districts, foundry	27/6
„ furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	55%	Tube prices are now free.
Water	50%	
Steam	45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/4½
„	28×20, „	38/10½
„	20×10, „	27/9
„	18¾×14, „	19/7½
I.X.		45/6
I.X.X.		52/-
F.C.B.Y.	21×13¾ „	38/3
C.V.B.G.	16¾×15, „	35/-
I.C.W.	20×14, „	17/-
„	28×20, „	34/-
„	20×10, „	23/7½
„	18¾×14, „	17/3
Terneplates,	28×20, „	35/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Aug. 9	64	12	6	dec. 10/-
„ 10	64	2	6	„ 10/-
„ 11	64	2	6	No change
„ 14	64	2	6	„
„ 15	63	17	6	dec. 5/-

Electrolytic Copper.

Aug. 9	71	0	0	No change
„ 10	70	10	0	dec. 10/-
„ 11	70	10	0	No change
„ 14	70	0	0	dec. 10/-
„ 15	70	0	0	No change

Standard Tin (cash).

Aug. 9	160	2	6	dec. 30/-
„ 10	159	2	6	„ 20/-
„ 11	158	10	0	„ 12/6
„ 14	158	15	0	inc. 5/-
„ 15	158	17	6	„ 2/6

Tin (English ingots)

Aug. 9	160	0	0	dec. 30/-
„ 10	159	0	0	dec. 20/-
„ 11	158	10	0	„ 10/-
„ 14	158	10	0	No change
„ 15	158	15	0	inc. 5/-

Zinc Sheets (English).

Aug. 9	37	10	0	inc. 10/-
„ 10	37	10	0	No change
„ 11	37	10	0	„
„ 14	37	10	0	„
„ 15	37	10	0	„

Spelter (ordinary).

Aug. 9	31	10	0	dec. 5/-
„ 10	31	5	0	„ 5/-
„ 11	31	0	0	„ 5/-
„ 14	31	5	0	inc. 5/-
„ 15	31	5	0	No change

Lead (English).

Aug. 9	26	10	0	No change
„ 10	26	5	0	dec. 5/-
„ 11	26	0	0	„ 5/-
„ 14	26	0	0	No change
„ 15	26	0	0	„

We manufacture and can supply immediately

LOW GRADE

FERRO SILICON

8/10% 10/12% 12/15% and 20/25%.

THE NEWCASTLE ALLOY CO., LTD.,
Milburn House,
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GIVE THE BRITISH MANUFACTURER FIRST CHANCE.

SHROPSHIRE IRON Co., Ltd.

Works:— Hadley, Shropshire.
London: 10, Bush Lane, Cannon St., E.C.4.
Telegrams:— Sun, Wellington, Salop. Sunbrand (Cannon), London.
Telephone:— 11 Wellington, Salop. 5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

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JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

FOUNDRY COKE

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

TO NON-FERROUS FOUNDERS, ETC.

If you need a Foundryman, as Manager, Assistant Manager or Foreman—Advertiser, age 39, with 25 years' practical experience (including plate and machine moulding) acquired as moulder, coremaker, foreman (11 years); with a thorough technical training, I.C.S. diploma modern foundry practice, Member Institute British Foundrymen, a knowledge of Book-keeping, and of costs systems, capable estimator from Blue Prints, and whose motto is, "Efficiency achieves Economy," then please write "J," 196, Merton Road, Wandsworth, London.

FOREMAN PATTERNMAKER, specialising in Machine Moulding, seeks engagement with progressive firm; first-class references.—Replies to Box 234, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN MAKER. Age 30. Large experience in both shop and foundry, desires to obtain employment in modern or progressive foundry where thorough knowledge of machine and plate moulding and foundry work can be obtained, also facilities for studying production and economy desirable.—Apply, TYNESIDER, Offices of the FOUNDRY TRADE JOURNAL, 5, Duke Street, Adelphi, London, W.C.2.

IRON AND STEEL TRADE.—Active Agent established in the Charleroi district is anxious to meet big exporters wishing to place advantageously in Belgium their orders in bars, joints, tees, angles, etc. —A. G., ECLAIR PUBLICITE, Charleroi (Belgium).

EXPERT FOR FOUNDRY TECHNICAL INSTITUTE, FALKIRK, WANTED. State age, experience (including teaching), salary required, etc. Replies to JAMES ALLEN, 24, Newmarket Street, Falkirk.

MACHINERY.

FOR SALE.

160-kw. 3-phase Generating Set, by Scott & Mountain, Compound Engine, direct coupled to 3-phase Alternator 550 volts per phase, 40 cycles, 300 revs. Powerful Electric Winch, drum 3 ft. 6 in. dia., 3 ft. long, Motor 450 amps., 100 volts, 520 revs., by Clarke, Chapman & Company, Limited. 100 b.h.p. 3-phase Slip Ring Motor, ventilated type, 50 periods, 200 volts, 575 revs., by British Thomson Houston Company. Vertical Compound Open Type Engine, 12 in. and 19 in. cyls., 12 in. stroke, by Tangyes, Limited. Cross Compound Horizontal Engine, 11 in. and 19 in. cyls., 26 in. stroke, by Marshall Sons & Company, Limited. Two Twin Spindle Vertical Boring, Drilling and Tapping Machines, by D. & J. Tullis, 2¾ in. spindle, T-slotted table working surface, 5 ft. 6 in. x 4 ft. Horizontal Boring Machine, by the Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. Worthington Horizontal Duplex Pump, 14 in. x 12 in. x 10 in., 10 in. suction, 8 in. delivery. Surface Condensing Plant, by F. Pearn & Company, 10 in. and 16 in. steam cyls., 12 in. stroke, air pump 18 in., circulating pump 12¾ in., surface area 1,200 ft., 12 in. stroke Shaping Machine, two tables 21 in. x 13 in. x 13 in., by Jas. Archdale & Company, Limited.

Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

THOS. W. WARD. LTD.,
ALBION WORKS,
SHEFFIELD.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

55 H.P. Vertical Petter Crude Oil Engine; two Magnificent Electric 3-throw Hydraulic Pumps, 4½in. rams, 220 volts d.c.; 2½in. and 4in. Electric Centrifugal Pumps, 220 volts d.c.; nine, nearly new, 5-Ton Hopper Wagons; Manning Wardell Locomotive, 9in. cylinders. Details.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

MACHINERY —*Contd.*

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

AUCTION SALE.

By direction of the Right Hon. the Viscount Hood.

NORTHAMPTONSHIRE.

Within 2 miles of Kettering (M.R. main line); 7 miles from Wellingborough; Cranford Station (M.R.) and Butlins Sidings adjoining.

THE IMPORTANT FREEHOLD AGRICULTURAL AND MINERAL PROPERTY

known as

"THE BARTON SEAGRAVE ESTATE,"

lying within a ring fence, in the Parish of Barton Seagrave, near to the town of Kettering, bounded by good hard roads, intersected at the south-east corner by the Midland Railway, and containing an area of about

854 ACRES, with the

VALUBALE BEDS of IRONSTONE lying thereunder.

To be Offered for Sale by Auction as a whole, or in 2 lots (if not previously disposed of by private treaty), by

BERRY BROS. & BAGSHAW,

at the George Hotel, Kettering, on Friday, September 8th, 1922, at 4 o'clock in the afternoon precisely.

Particulars, with Plans, may be obtained of the Solicitors, Messrs. Broughton, Holt & Middlemist, 12, Great Marlborough Street, London, W.1.

Land Agents: Messrs. Fisher & Co., Market Harborough.

Auctioneers: Messrs. Berry Bros. & Bagshaw, Kettering.

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S. G. SMITH,

Iron Foundry Expert,

Late Foundry Specialist with Metropolitan Vickers Electrical Company, Limited, Trafford Park, Manchester,

Is again available for consultations, investigations, and advice on all matters appertaining to Iron Foundries and Castings.

Upwards of 40 years' active experience of work of all classes.

Author of Articles covering Modern Foundry Practice, including

Foundry Lay-out and Design,
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Cupola Practice and Management,
Moulding and Facing Sands, Blackings, etc.,
Loam and Sand Procedures, etc., etc.,

Lecturer and Teacher on Foundry Processes at the College of Technology, Manchester.

Practical Tuition to Foundry Students, private, or in classes; also Universities, Colleges, and Technical Schools.

Consultations, away or at home, by appointment. Terms, reasonable and satisfactory.

MOULDING MACHINES.

One Tabor Jolt Ram Stripping plate machine for boxes 26″ x 26″	£100	
Four Tabor Split pattern power draft squeezers for boxes 16″ x 14″	£80	each
Two Mumford Split pattern power draft squeezers for boxes 18″ x 12″	£80	each
Two Tabor Split pattern power draft squeezers for boxes 18″ x 18″	£90	each
One Darling & Sellars hand-ram turnover machine for boxes 36″ x 24″	£30	
One Darling & Sellars hand-ram turnover machine for boxes 20″ x 16″	£25	
Two Evans flypress New hand squeezers for boxes 16″ x 16″	£12	each
Two Evans Duplex pneumatic squeezers for boxes 20″ x 20″	£90	each

ALEX. HAMMOND,
"BOXTED"—SLOUGH.
All the above in my Stock at Slough.

Small Advertisements continued on p. 15.